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THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY

OF

LONDON.

VOLUME XXI.

MISSOURI
BOTANICAL
GARDEN.

LONDON:

PRINTED BY TAYLOR AND FRANCIS, RED LION COURT, FLEET STREET:

SOLD AT THE SOCIETY'S HOUSE, SOHO-SQUARE;

AND BY LONGMAN, BROWN, GREEN, AND LONGMANS, PATERNOSTER-ROW.

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M.DCCC.LV.

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AND WILLIAM WOOD, TAVISTOCK-STREET, COVENT-GARDEN.

M.DCCC.LII.

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TRANSACTIONS

OF

THE LINNEAN SOCIETY.

I. *On the Genus* Atamisquea, *belonging to the Family of the* Capparidaceæ.

By JOHN MIERS, *Esq., F.R.S., F.L.S. &c.*

Read January 18, 1848.

A TREE belonging to the Natural Order *Capparidaceæ*, growing in the arid desert plain at the foot of the Cordillera de los Andes, which I examined with some attention in 1825, and which I then named *Atamisquea emarginata* (Travels, vol. ii. p. 529), was also found about the same time by the late Dr. Gillies, from whose specimens Sir W. Hooker subsequently first published its generic character (Botanical Miscellany, vol. iii. p. 143); but as my Notes upon the living plant, illustrated by drawings made at that time, vary in some respects from the excellent description given by that very distinguished botanist from dried specimens, I have thought that my observations upon this little-known genus may perhaps be acceptable to the Linnean Society.

ATAMISQUEA, *Miers.*

CHAR. DIFF. *Sepala* 2, magna, ovoidea, concava, æstivatione marginibus subimbricatis, cum toro carnoso cyathiformi persistente demùm indurato dentibus erectis notato basi coalita, decidua. *Petala* 6, e margine tori orta, inæqualia, lineari-spathulata, reflexa; 2 superiora erectiora, æstivatione subimbricata; 2 lateralia breviora, exteriora. *Stamina* 9, quorum 6 fertilia, longiora; *filamenta* æstivatione replicata, demùm recta, declinata, glabra, basi glandulosa, lepidota; *antheræ* oblongæ, 2-loculares, basifixæ, erectæ, demùm curvatæ. *Thecaphorum* declinatum, basi glabrum, disco staminifero cinctum, hinc geniculatum; indè gracile, elongatum, et cum ovario lepidotum. *Ovarium* ovatum. *Stylus* brevissimus. *Stigma* obtusè 2-lobum. *Bacca* ovoidea, subcarnosa, densè lepidota. *Semina* 2 (vel abortu 1), exalbuminosa, cochleato-reniformia, funiculo libero erecto 2-furcato ex imo loculo orto lateraliter appensa. *Testa* coriacea, loculo altero incompleto hilo opposito. *Embryo* campylotropus; *cotyledones* magnæ, foliaceæ, invicem plicato-convolutæ; *radicula* teres, infera, sursùm spectans.

CHAR. NAT. *Sepala* 2 (anticum et posticum), ovoidea, concava, æstivatione marginibus subimbricatis, intùs hirsuta, extùs lepidota, decidua, basi (toro adnato) coalita. *Torus* ovalis, cyathiformis, carnosus, persistens, demùm induratus, obliquè gibbosus, margine superiori altiori, dente erecto sub-

2-fido, et lateraliter dente utrinque notatus. *Petala* sex, inæqualia, lineari-spathulata, intùs villosa, extùs lepidota, reflexa, æstivatione subimbricata, duobus lateralibus brevioribus, exterioribus, et cum sepalis alternis, duobus superioribus post anthesin reliquis erectioribus; omnia è margine tori orta. *Stamina* novem, quorum sex fertilia, disco gibbo tenui annulari thecaphorum cingenti adnata: *filamenta* glabra, æstivatione replicata, demùm recta, sursùm declinata, basi glandulâ liberâ, obovatâ, carnosâ, hirsutissimâ, et sparsè lepidotâ munita; tribus sterilibus reliquis brevioribus, fertilibus petalis longioribus: *antheræ* basifixæ, loculis duobus coriaceis obliquè adnatis intùs longitudinaliter dehiscentes, demùm curvatæ. *Thecaphorum* è basi tori sublateraliter ortum, declinatum, basi ampliatum, glabrum, disco annulari staminifero cinctum, hinc geniculatum, indè gracile elongatum, et sursùm inflexum, longitudine staminum, et cum ovario apicali lepidotum. *Ovarium* ovatum. *Stylus* brevissimus. *Stigma* obtusè bilobum. *Bacca* ovoidea, stylo apiculata, densè lepidota, 1-locularis, pulpâ parcâ farcta, post siccationem in valvas quatuor pressione solubilis, sed non dehiscens; replo* epicarpio delapso persistente. *Semina* 2 (vel abortu unicum), exalbuminosa, cochleato-reniformia, in pulpâ subsuccosâ funiculo libero erecto bifurcato ex imo loculo orto lateraliter appensa. *Testa* coriacea, loculo altero incompleto hilo opposito. *Embryo* campylotropus: *cotyledones* magnæ, foliaceæ, incumbentes, invicem plicato-convolutæ: *radicula* teres, infera, loculo simulato celata, et ob embryonis curvaturam, hilum supernè spectans.

Frutex *durus, ramosus,* Americæ Meridionalis extratropicæ; ramis *abbreviatis, junioribus sublepidotis, nonnunquam spinescentibus*; foliis *è ramulis junioribus ortis, parvis, alternis, brevissimè petiolatis, canaliculatis, æstivatione conduplicatis, faciebus superioribus invicem applicitis, subtùs lepidotis, costâ carinatâ*; pedunculis *axillaribus, solitariis, unifloris.*

1. Atamisquea emarginata (*Miers, Trav.* ii. p. 529): foliis lineari-oblongis basi apiceque emarginatis suprà viridi nitentibus subtùs hirsutis incanis squamisque lepidotis tectis.

Hab. In campis patentibus aridis, salinis, *Travesia* dictis, provinciæ Mendozæ.

The generic title is derived from the vernacular name, *Atamisque.* It is a tree of withered and barren appearance, not exceeding 8 or 10 feet in height; the trunk is very solid, and much bent; the wood, hard and of close grain, is of a yellow colour; the bark is very thin and smooth, formed of several yellowish green, membranaceous laminæ, peeling off in flakes, and exposing the bare yellow wood. The branches are much bent and tortuous; the younger shoots, which are furfuraceous and of a whitish hue, alone bear leaves. The leaves are alternate, broadly linear, emarginate at both ends, 3 lines long and 1 line broad, of a somewhat coriaceous texture, veinless, very entire, polished, and of a dark green above, with a central longitudinal groove over the midrib: in the young state their upper face folds inwardly, with the margins adhering closely together; and when

* The term *replum,* used by Mr. Brown, Prof. Endlicher and other botanists for the indurated margins of seed-vessels that remain after the valves have fallen away, has been objected to by Mr. Bentham (Hook. Journ. Bot. iv. p. 326), who thinks that it is defective and unnecessary, as the word *margo,* the meaning of which is clear, answers the purpose equally well. In the instance to which he refers (that of the persistent sutural margins of the legumes of *Mimoseæ*), the latter expression is certainly well adapted; but in the case above described, where no margin, nor any true valve can be said to exist, the latter term does not apply; for the thin epicarp appears entire and supported upon the four fibrous ribs that, rising from the base and uniting in the style, serve to support this epicarpal envelope: and although it may be assumed that its origin is due to the confluence of four carpellary leaves, of which these processes may have formed the midribs, they certainly appear finally under a form that seems better expressed by the term *replum* than by that of *margo.*

they at length open, the leaf always remains somewhat canaliculate: below it is whitishly furfuraceous, being covered with a tomentous down, that is almost wholly concealed by a number of closely imbricate peltate scales with radiate ribs, which under a lens appear like fish-scales: the petiole is short, white, and also lepidote. The flowers often axillary, sometimes terminal, are altogether covered with imbricate scales; the peduncles, one-fourth to three-eighths of an inch in length, are usually solitary, but sometimes in pairs. The sepals are rounded, very deeply concave, the margins being very slightly imbricate before expansion; they are at first reflexed, and soon break off transversely along the margin of the torus; they are covered within by tomentous whitish hairs, and are lepidote outside. The torus is a fleshy deep oval cup, which after the fall of the flower becomes hardened, and exhibits a somewhat bifid, erect tooth on its posterior or upper margin, and two other smaller opposite teeth on its sides. The six petals arise in a single whorl from the inner margin of the calycine cup, and are linear, and somewhat spathulate, being hairy within, and covered on the outside with lepidote scales: four of these are of equal length, and situated in pairs, opposite the sepals, while the two intermediate shorter petals are lateral, and alternate with the two sepals; in æstivation, the margins of the summits are somewhat imbricately disposed, those of the shorter pair being exterior to the others; after expansion they are all thrown back, the upper pair remaining more erect. There are six fertile and three sterile stamens, all seated upon a small gibbous ring, just above the glabrous thickened base of the thecaphore; the sterile filaments are shorter than the others, one of them being opposite to the upper petals, and the other two opposite to the lateral petals, two fertile stamens interposing between them; the fertile filaments are as long as the petals, and though somewhat plicated before expansion, are afterwards erect, and deflected outwards near the summit; they are quite glabrous, with a roundish fleshy gland at the base, which is covered with whitish pubescence, and a few lepidote scales; these glands being seated upon the gibbous ring before mentioned, make it almost appear as if the stamens were monadelphous, but they are in reality free to the base. The anthers, which are oblong and basifixed on the apex of the filaments, are coriaceous, 2-celled, burst inwardly by longitudinal furrows somewhat in front, and afterwards curl downwards in an annular form. The thecaphore arises somewhat laterally from the bottom of the hollow cup-shaped gibbous torus, and is inclined upon its shorter side; the lower part, which is glabrous, rises to the height of the cup, forming the staminiferous support above mentioned, one side of this support adhering to the lower and shorter portion of the cup, the opposite side being free and channeled almost to its axis; above this level the thecaphore becomes more slender, is again inclined further downwards, and rising to the height of the stamens bears upon its summit the ovarium, which, with the slender portion of the thecaphore, is densely lepidote. The ovarium is of an oval form, somewhat nodding; the style is very short, and the stigma is almost obsoletely 2-lipped. The fruit is a somewhat fleshy berry, covered with lepidote scales, about 3 lines long and 2 lines in diameter; it is unilocular, bearing generally two seeds, which almost fill the cavity; the epicarp is thin and somewhat coriaceous, and separable by pressure into four equal segments, leaving the seeds, and the small quantity of enveloping pulp, contained within four slender cartilaginous ribs, which arise from the base of the cell and unite in the apex; these ribs corre-

spond with the edges of the segments, which show by their laceration that their adhesion with each other and with the ribs has been complete. Within and opposite to the lowermost of these ribs arises a funiculus or placenta, which on reaching about two-thirds the height of the fruit, branches off right and left, by two short threads, towards the hilum of the two seeds, where they are respectively attached. The seeds are smooth, of a dark red colour, reniform, or of a cochleate shape, somewhat flattened on their adjacent sides, and roundish without. The testa is coriaceous, having on one side an incomplete cell, formed by the convolution of the inner margin about the umbilical sinus; the outer integument is brownish, opake, and striated, and adhering to the testa forms between the flexure of the embryo an extension of the false dissepiment of the spurious cell, which serves to inclose the radicle: the inner integument is membranaceous, and marked about the middle of the cotyledons with a broadish thickened chalaza. The embryo is oblong, and bent sharply inwards at both extremities, the ends of the cotyledons and of the radicle being mutually turned towards each other, so that it may be said to be truly campylotropous: the cotyledons are convolutely plicated, and somewhat white and foliaceous.

From the facts above stated it may be inferred, that the arrangement of the floral envelopes in this genus is contrary to the usual structure of the *Capparidaceæ*, which offer generally four sepals, four alternate petals, usually eight or more stamens, and a fruit, usually of two cells, with two or more placentæ. Sir W. Hooker, in his generic character of *Atamisquea* (*loc. cit.* p. 143), regards its floral teguments as consisting of four sepals and four petals, in conformity with the ordinary arrangement in this family: it will be seen, however, that I have ventured to differ with that distinguished botanist in this respect, as I regard the two outer valviform envelopes as the true calyx, while the six linear segments appear to me to constitute the corolla, a view which I offer with much deference against the opinion of so high an authority. It appears to me however warranted by the fact, that these external broad leaflets form one entire whorl, as they are continuous at their origin with the margin of the cup of the torus, while the insertion of the six narrower segments (petals) is upon one line, within the margin of the same cup, which is proved by the fact, that when the sepals and petals fall away, the rupture of the former is marked by a clean line on the margin of the cup, while the remains of the claws of the petals are distinctly seen within the line of the same margin as so many projecting indurated teeth, as shown in fig. 9. This view, although opposed to the ordinary structure, is nevertheless supported by analogy in three other genera of this family, where only two sepals exist, or an entire envelope that bursts into two valves, viz. in *Busbeckia*, Endl., *Steriphoma*, Spr., and *Morisonia*, Plum. The apparent inconsistency of this distribution will disappear, if we consider the floral envelope as formed of three series, each consisting of two normal parts, the inner series appearing double, from the cleaving of the lobes down to their point of insertion; for in the origin of each upper and lower pairs of petals upon the torus there exists a manifestly distinct interval between them and the two lateral intervening shorter petals, and when the former are pulled away from the cup they cohere together in pairs by their base. Or we may still consider the normal structure as composed of two series, each of four leaflets; the sepals, from their shape and great width, may be considered to constitute a complete whorl, and may be imagined to have been formed by the cohesion

of four segments into two, while the inner series of six segments may be viewed as normally consisting of four leaflets, that is to say, with two of the opposite petals somewhat depauperated, while the intervening ones are cleft nearly to their base. This latter view is rendered somewhat the more probable, by the apparent insertion of all the six petals upon one line, and by the cohesion of the upper and lower pairs by their claws, when torn away from their place by force: the appearance of the teeth, or indurated remains of the claws of the petals, that are distinctly seen on the inner margin of the persistent calycine cup, corroborates this view of the case, which is further confirmed by the fact, that when dried each of the sepals by pressure easily splits down the middle, by a clean line, into two distinct segments.

EXPLANATION OF THE PLATE.

Tab. I.

Atamisquea emarginata.

Fig. 1. The flower, shown in æstivation.

Fig. 2. The same, with the two sepals expanded, the petals still remaining closed.

Fig. 3. The same, fully expanded:—all of the natural size.

Fig. 4. A magnified view of fig. 2, to show the mode of æstivation of the petals.

Fig. 5. A magnified view of fig. 3.

Fig. 6. The same, with the sepals and petals fallen away, to show the mode of insertion of the stamens and thecaphore in the calycine cup.

Fig. 7. The petals, showing the basal union of the two longer pairs.

Fig. 8. The six fertile and three sterile stamens, shown distinct, with the gland at the base of each filament: the mode of their æstivation, and the curled appearance of the anthers after dehiscence, is also seen.

Fig. 9. A magnified view of the calycine cup, after the sepals, petals, and stamens have fallen away; showing the persistent teeth (which are the indurated remains of the claws of the petals), and the portion of the thecaphore, with its glabrous base, and the discal ring, to which the filaments are attached.

Fig. 10. A berry, of its natural size.

Fig. 11. The same, magnified.

Fig. 12. The same, with the epicarp and pulp removed, exhibiting the manner in which the two seeds are suspended, and nourished by the placenta.

Fig. 13. The same, with the seeds removed also, to show the persistent replum and bifurcate placenta.

Fig. 14. The seeds magnified, seen edgeways, and in front.

Fig. 15. A longitudinal section of the testa, showing the nucleus, with its extremities curved inwards, and inclosed within the false cell of the incomplete dissepiment.

Fig. 16. The same, with the nucleus removed.

Fig. 17. The nucleus extracted, showing the endopleura, with its chalaza.

Fig. 18. The embryo in its natural form, deprived of its integuments.

Fig. 19. The same, with the cotyledons expanded, to show the mode of their plicated convolution.

J. Miers Esq. del.

G. Jarman Sc.

II. *On the Development of the Ovule in* Orchis Morio, *Linn.*

By Arthur Henfrey, *Esq., F.L.S. &c.*

Read April 3, 1849.

In the spring and summer of last year I made many observations on the young ovules of various plants, with the view of testing the various doctrines on this subject, which had acquired new interest from the recent researches of Amici, Mohl and others. Only one series of my investigations attained anything like completeness; but in *Orchis Morio* I believe that I have seen and can confirm all that the above-mentioned observers have described; and I now present my results to the Linnean Society, partly because I believe that in the present state of the question all evidence derived from careful observation is of some value, and partly because I have succeeded in obtaining a more complete series of figures illustrating the successive conditions of the ovule than has yet been published; Mohl, who gives the most complete account of the development in *Orchis Morio*, having given no drawings. The following account is drawn up from my notes made during the observations, principally in the month of May 1848.

May 3rd. In the ovaries of flowers which had just opened, and were without signs of pollen upon the stigmatic surface, the ovules, about $\frac{1}{200}$th of an inch long, were just curving over toward the anatropous position; in some the axis of the nucleus formed nearly a right angle with the funiculus (Tab. II. figs. 4 & 5). The nucleus projected beyond the cells, forming the single coat of the ovule, and consisted of a large central cell (the embryo-sac), enclosed by a layer of very delicate cells of small size, constituting a proper coat of the nucleus.

May 9th. The ovules of fully expanded flowers were not much altered, except in the much clearer definition of the walls of the cells. The embryo-sac was filled with a clear, colourless fluid, in which floated minute black atoms, scarcely large enough to deserve the name of granules. In some flowers the stigmas were smeared with pollen, but often from the anthers of other flowers, their own being still closed. These pollen masses sent down numerous tubes, which differed much from any of the cells of the tissue in which they were engaged. The pollen-tubes were always about $\frac{1}{4000}$th of an inch in diameter, at most one-fourth of the size of the smallest of the surrounding cells, which were also short and often irregular in form, while the pollen-tubes always appeared as long, slender filaments.

May 13th. The flowers withered and the stigmas covered with pollen. A dense bundle of tubes lay in the midst of the lax tissue of the canal leading to the cavity of the ovary. The ovules were considerably advanced, some being quite anatropous (fig. 6), others three-fourths reversed; those quite anatropous were about $\frac{1}{100}$th of an inch in length. The two coats of the ovule (tegmen and testa) were now distinctly evident; the length of the testa

varied; sometimes it half enveloped the tegmen, in some ovules it had grown up further over it. The inner coat, the tegmen, had not grown over the nucleus in all the ovules, but in most it projected beyond. The nucleus was still covered by its own cellular coat, and still contained only the clear, colourless fluid with black points.

May 16th. The ovaries more advanced; the pistillary cords extended nearly to the base of the ovary, lying in the grooves formed between the projecting placentas and the walls of the ovary, apparently free, and composed of delicate tubes presenting all the characters of pollen-tubes, and apparently continuous with these, as derived from the pollen on the stigma. The ovules (fig. 8) exhibited considerable alteration. Most of them were enlarged, and the outer coat had developed much in the chalazal region; its cells were larger and more clearly defined. The inner coat, which appeared to be tolerably independent of the outer at the sides, as air passed freely between them, had grown up far beyond the nucleus, and its cell-walls had acquired more consistence. The nucleus was much changed; the embryo-sac had lost its proper cellular coat, which had disappeared either by solution or by pressure, probably the former, as a free space existed sometimes between the inner coat and the nucleus; and in some cases the solution appeared imperfect, extending only to the cross walls of the cells, so that the embryo-sac was contained in an outer sac consisting merely of the outer walls of the cells of its coat. The embryo-sac now had the aspect of a large ovoid sac attached by a cellular pedicle to the chalazal region, and contained opalescent mucilaginous matter (protoplasm), in most cases accumulated at the ends, chiefly at that next to the micropyle. There was no sign of a nucleus or nascent cell yet.

May 20th. The embryo-sacs exhibited the collections of protoplasm at the two ends. At the micropyle end new phænomena presented themselves: either one, two, or (and usually *) three minute vesicles (figs. 11–14) had been formed from the protoplasm, and always seemed to me to originate as cavities excavated in the mucilage, not as if formed by the formation of membrane on the outer surface of a nucleus (cytoblast) or globule of mucilage. These vesicles soon appeared as distinct cells, with exceedingly delicate walls, lying at the micropyle end of the embryo-sac, and undoubtedly existed there before the pollen-tubes entered the foramina of the ovules.

In some of the ovules examined this day the pollen-tubes had entered the ovules, and I traced them down through the wide mouth of the outer coat and the narrow canal of the inner, as far as the apex of the embryo-sac. They never entered this, but generally appeared to be diverted a little to one side, and to lie in contact with its outer surface †, just over the place where the minute vesicles lie within.

May 31st. I examined a number of ovules in various stages, repeating the observations on the earlier conditions with similar results. I traced the pollen-tube down to the embryo-sac in several specimens (fig. 15): in one case it appeared flattened against the membrane of the embryo-sac (fig. 17); in other cases (figs. 15, 16, 19, 20) I traced it a little way

* It is probable that there are always three; but as they vary in size and lie close together, one or even two of them may be hidden in certain cases.

† The end of the pollen-tube exhibits dark contents when in contact with the embryo-sac.

down the side of the summit of the embryo-sacs, which always contained the vesicles within. In some embryo-sacs (figs. 20–26) one of the vesicles had begun to develope further, dividing into two cells by a horizontal septum, the upper dividing again and growing out in a conical form through the endostome, to produce the confervoid filament which was described by Mr. Brown, and which Schleiden has certainly mistaken for a development of the pollen-tube.

June 3rd. Traced the pollen-tubes to the embryo-sac, and saw them lying on the outside, and again satisfied myself that the vesicle within the embryo-sac (the germinal vesicle) is the first cell of the embryonic body. It generally exhibits a slight collection of protoplasm at its base, and soon after the pollen-tube reaches the surface of the embryo-sac divides into two cells, the upper dividing again and growing out into an articulated filament, the cells of which are formed by the production of septa in the same way as in Confervas, hairs of *Phanerogamia*, &c., the mucilaginous layer (or primordial utricle of Mohl) being rendered very evident by the application of iodine (fig. 29). The lower part of the embryonic body enlarges while the filament is growing out, and soon perfectly fills the embryo-sac. It appears to me that the process of cell-formation in this lower part, by which the embryo is produced, varies in different cases; generally the lowest cell enlarges very much and becomes filled with dark mucilaginous matter, and then this is soon divided into a number of cells by the formation of septa. Nuclei were visible in all the cells very soon after their origin, but I could not form an opinion as to their relation to the cell-formation, or determine how or at what period they were really produced. In the earliest condition they resembled clear vesicles, not granular bodies such as Schleiden describes.

In some cases two confervoid filaments are produced, two of the germinal vesicles undergoing development. I met with this several times, but omitted to draw them, in the hope of subsequently finding a more favourable specimen, which I was not fortunate enough to do.

The obvious conclusions from the foregoing observations appear to be, that the embryo is really produced by the ovule itself; that a germinal vesicle exists within the embryo-sac before the pollen exerts its influence; that the pollen-tube penetrates the coats of the ovule to reach the embryo-sac; and that the passage of the pollinic fluid through the intervening membranes impregnates the germinal vesicle and determines its development into an embryo.

Since the investigations were made with every precaution, and their results are in perfect accordance with those of Amici, Mohl, Müller and others, I think that I am justified in believing them to be a sufficient refutation of Schleiden's views, so far as the plant in question is concerned; but as to their positive value, as to the evidence they afford of the actual nature of the process of impregnation, I still regard them as insufficient. I am not convinced that the whole of the pistillary cords are composed of filaments directly produced by the pollen-granules. It is not yet shown whether there is any relation between the application of the pollen on the stigma and the development of the germinal vesicles; it is only clear that these last exist before the pollen-tubes enter the ovules.

Lastly, although the production of the confervoid filaments appears to be a normal process, it is still a question open to doubt when only observed in ovaries containing such an abundance of ovules as *Orchis Morio*.

The facts I have detailed above are, however, agreeable with what I have observed in certain other plants, in some as yet imperfect investigations; I hope to be able to complete them, and to repeat the earlier examinations with especial reference to the doubtful points, in the course of the ensuing summer.

EXPLANATION OF THE PLATE.

Tab. II.

(The Figures are all magnified about 200 times.)

Orchis pyramidalis.

Fig. 1. A young ovule.

Fig. 2. The same, somewhat more advanced. The ovule presents a single coat, enclosing the nucleus, which consists of a layer of cells (the coat of the nucleus), surrounding a large central cell (the embryo-sac).

Fig. 3. An end view of the summit of the last.

Orchis Morio.

Fig. 4. A young, almost erect, ovule with a single coat, from which the nucleus projects.

Fig. 5. A more advanced ovule, curving round and exhibiting the nucleus and embryo-sac more distinctly.

Fig. 6. More advanced stage, ovule almost anatropous; both coats are now distinguishable, the inner projecting out from the outer, and the nucleus beyond the inner.

Fig. 7. The inner coat has grown over the nucleus, which still retains its proper cellular coat (7 *a*).

Fig. 8. The outer coat has grown up further; the nucleus has lost its coat, and is now a simple sac filled with a clear fluid in which float black granules (8 *a*).

Fig. 9. The outer coat almost completely covers the inner, which, with the nucleus, is indicated by dotted lines. The endostome is now very narrow; the nucleus contains mucilaginous matter (protoplasm, 9 *a*).

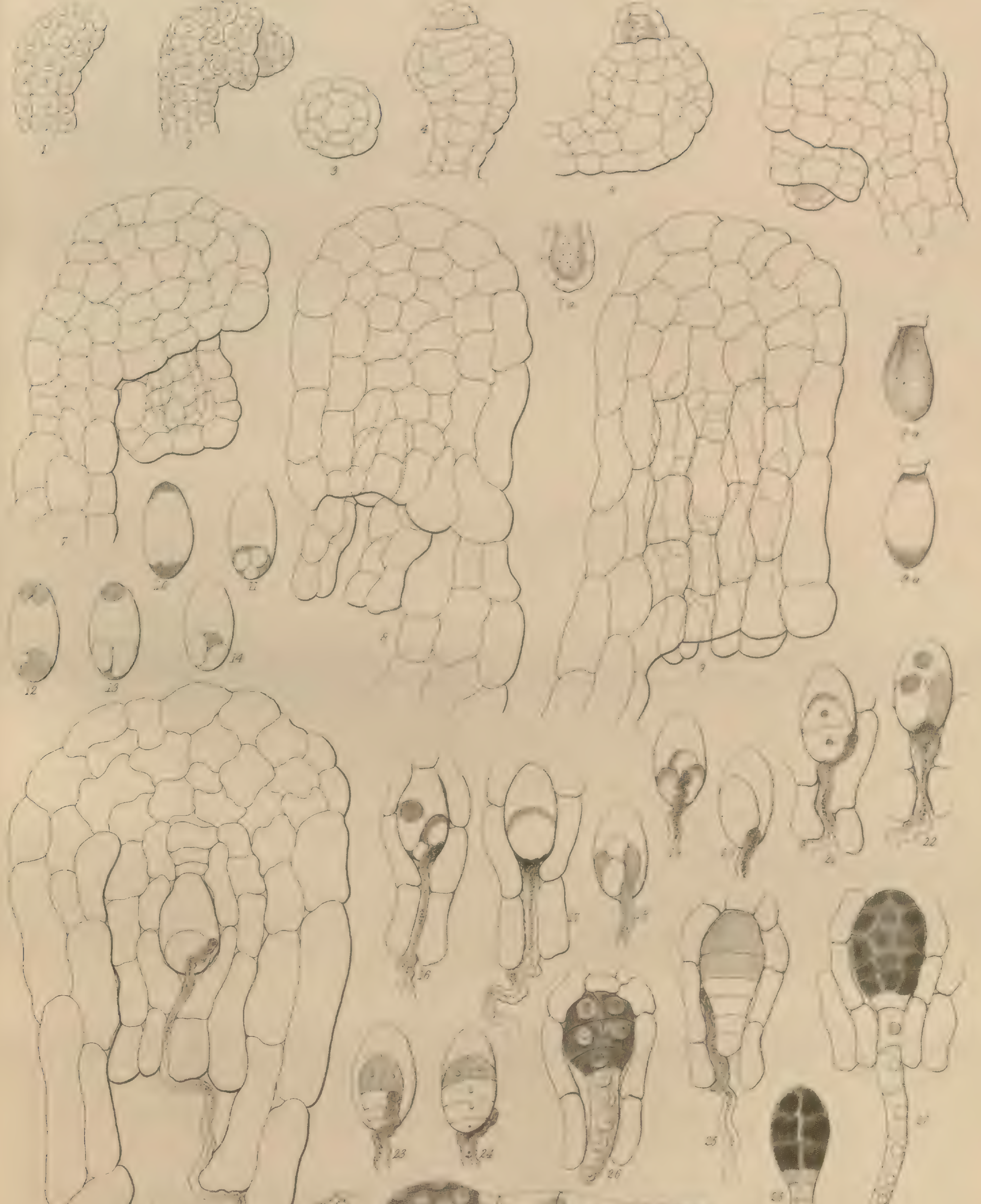
Fig. 10 to 14. Embryo-sacs from ovules a little more advanced than in fig. 9, exhibiting the vesicles at the micropyle end.

Fig. 15. An ovule with the pollen-tube penetrating. The exostome is a wide mouth, the endostome very narrow. The blind extremity of the pollen-tube lies upon the outside of the embryo-sac, within which is seen one large germinal vesicle.

Fig. 16 to 22. Embryo-sacs with pollen-tubes in contact, and with germinal vesicles within. In

Fig. 20 & 21 the germinal vesicle has divided into two cells by the formation of a transverse septum.

Fig. 23 to 29. Different stages of development of the confervoid filament from the pro-embryo. In fig. 25 the pollen-tube lies beside it. In fig. 29 the upper cells of the filament exhibit the contracted mucilaginous layers (primordial utricles) detached from the cell-walls. The lower part, which produces the embryo, is filled with opake mucilage, which appears to divide into separate cells in various ways.



A. Henfrey Esq. del.

G. Jarman Sc.

III. *On the Australian Species of the Coleopterous Genus* Bolboceras, *Kirby*. *By* J. O. Westwood, *Esq.*, *F.L.S.*

Read March 21st, 1848.

Bolboceras, a genus of Lamellicorn beetles, was proposed by the Rev. W. Kirby, in his excellent memoir published thirty years ago, in the 12th volume of the 'Transactions of the Linnean Society,' containing descriptions of New Australian *Coleoptera* collected by Mr. Robert Brown. In his observations appended to the Latin characters given of the genus, as contrasted with those of *Geotrupes*, Mr. Kirby more especially endeavoured to point out the differences between these two genera, alluding, among other things, to the structure of the outer lobe of the maxillæ, but not mentioning (except in the Latin character) the horny inner lobe, with its bipartite structure, a character (as Mr. MacLeay has shown) of the highest importance, as distinctly indicating a variety in the operation of manducation, and consequently in the nature of the food of the insects. It is evident that Mr. Kirby's description of the maxilla of *Bolboceras* was drawn from the inaccurate figure of that part given in pl. 23. fig. 5*d*, which omits the upper portion of the lower lobe of the maxilla, which is thereby reduced to a single horny point. The maxilla of *Bolboceras* is, however, almost exactly similar to that of *Athyreus*; indicating, in conjunction with the general appearance of the insects, an analogous mode of life, although the difference in the place of insertion of the middle feet must evidently be regarded as a proof of some distinction in the habits of the two genera.

Mr. Kirby's observations, it will be further seen, are directed to the structure of the antennæ and trophi alone. There are consequently two important characters derived from the external structure of the other parts of the insects which separate the two genera, rendering *Bolboceras* also as far removed from the type of the family *Geotrupidæ* as *Athyreus*. These are, the entire structure of the eyes in *Bolboceras*, whilst each eye is divided into two parts by a distinct septum in *Geotrupes*, and the want of a patch of orange plush-like hairs on the thighs of the fore-legs, which exists in *Geotrupes*.

Mr. Kirby mentions as belonging to *Bolboceras*, "*Sc. mobilicornis*, Linn. (of which *Sc. testaceus*, Fabr., is only a variety), *quadridens*, Linn., *farctus*, Fabr., *Lazarus*, Fabr., *Cyclops*, Oliv., &c.," together with the new species which he described under the name of *Bolboceras australasiæ*, a name now proved to be inapplicable, not only because we possess many Australian species of the genus, but also because the insect so described is but the female of another species. Of the above-mentioned species, the first, *Sc. mobilicornis*, does not belong to the genus *Bolboceras*, from which it is distinguished by its bipartite eyes, although the structure of the maxillæ and the want of a patch of plush on the fore femora show its near approach to it. It will therefore be proper to apply the generic name of *Odontæus*, given to this genus by Koppe, instead of *Bolboceras*, as it stands at

present in English collections and books. The species, moreover, which it will be advisable to regard as the type of *Bolboceras*, will be *Sc. quadridens*, Linn., as that was the species dissected by Mr. Kirby.

In 1819 Mr. MacLeay published the description of his genus *Elephastomus* in the first part of his 'Horæ Entomologicæ,' founded upon the singular Australian *Scarabæus proboscideus*, first described by Schreibers in the 6th volume of the 'Linnean Transactions.' In this strange insect the crown of the head is extended forwards, so as to push the ordinary front part of the head, including the clypeus, mandibles and labrum, quite underneath it; just as if the human forehead were dilated over the entire face, and the nose and mouth pushed between the chin and the throat; with this difference, that in the insect the horizontal upper lip and mandibles become perpendicular, whilst the opposite would be the case in a human head so deformed. Referring again to the structure of the maxillæ, we find Mr. MacLeay's description of those of *Elephastomus*, "Maxillæ corneæ, arcuatæ, intùs dente acuto et ad apicem laciniâ obtusâ ciliis spinosulis armatæ," incorrect, omitting to notice the upper portion of the inner lobe of the maxillæ; whilst the figure given of it, pl. 2. fig. 10 E, is still more incorrect, omitting both the horny teeth of the lower lobe. In this, however, and all its essential characters, this insect approaches so closely to *Bolboceras Australasiæ*, that, long ago, I had attached to a figure of *El. proboscideus* the following note: "Is not *Bolboceras australasiæ* of Kirby the female? The box-like clava of their antennæ agrees;" and in Dr. Klug's excellent Monograph on the genera *Athyreus* and *Bolboceras*, published in the 'Transactions of the Berlin Academy' for 1843, we find *Scarabæus proboscideus* given as the first species of *Bolboceras*, with *Bolb. Australasiæ* as its female. In fact, with the exception of the extraordinary formation of the head, and the alteration consequent thereupon in the *position* of the trophi, we can find no variation in the *structure* of these organs of higher importance (with reference to the question of the retention of *Elephastomus* either as a genus or subgenus) than the greatly elongated maxillary palpi and the identical structure of the two mandibles, which are bifid at the tips.

The number of the species of the genus *Bolboceras* was considerably increased by the late Mr. Bainbridge, who published a short paper on some of the Australian species, from the Collection of the Rev. F. W. Hope, in the 'Transactions of the Entomological Society'; by Messrs. Guérin-Ménéville and Castelnau, in their several works; and especially by Dr. Klug, in the monograph above referred to.

As some confusion has been introduced into the nomenclature of the Australian species, and as I have to add several hitherto undescribed ones from New Holland to the list, including a closely allied new genus, I have thought it would be desirable in this paper to concentrate the whole of the New Holland *Bolbocerata*. It may be proper to add, that my quotations of the species described from the Collections of Messrs. Hope and Gory have been made from an examination of the type specimens in Mr. Hope's Collection, with which is now also incorporated that of M. Gory.

The circumstance of so many of the largest species of this genus being inhabitants of New Holland, where, in consequence of the absence of the larger mammalia, it is impossible for them to possess the same habit of burrowing into and under dung, as the *Geotrupes* of our moderate climates, is in itself a sufficient evidence that the *Bolbocerata*, like

the *Athyrei*, must be regarded as very aberrant species in the family of which our *Geotrupes* is the well-known type.

It has been thought advisable that a continuation of this paper, containing descriptions of many additional new species of *Bolboceras* from India and other foreign regions, should be published as a distinct memoir, which accordingly appears as the following article.

1. Bolboceras (Elephastomus) proboscideus, MacLeay, ut supr. citat.

♀ *Bolboceras Australasiæ*, Kirby, loc. cit.

Obs. Caput et pronotum delineavi in Tab. III. fig. 1. ex individuo typico in Musæo Societatis Entomologicæ Londinensis.

Obs. 2. Figura maris in opere *Griffith's Animal Kingdom, Ins.* pl. 40. fig. 4, 4 *a*, 4 *b*.

Obs. 3. Varietatem maris (cum fœminâ *Bolb. Australasiæ* omninò congruenti copulâ captam) Societati Entomologicæ Londinensi communicavit D. F. Cox. Caput maris cornu perpendiculari infero caret, angulo parvo prominente locum ejus occupante.

2. Bolboceras (Elephastomus) Kirbii; castaneo-fulvus, capitis cornu antico porrecto brevi truncato plano subtùs in spinam bifidam haud producto, vertice carinâ brevi transversâ, prothoracis lateribus valdè punctatis utrinque fossulatis; disco posticè canali abbreviato longitudinali instructo.—Long. corp. lin. 9. (Tab. III. fig. 2.)

Bolb. (*Elephastomus*) *Kirbii*, Hope MS.

Hab. in Terra Van Diemen. In Mus. *Hope*.

El. proboscideo minor, corpus castaneo-fulvum. Caput elongatum; vertice carinâ transversâ, quasi e tuberculis conjunctis formatâ, in medio instructo; parte ante carinam porrectâ subquadratâ granulosâ anticè parum latiori apice utrinque rectè truncato, cornu antico abbreviato plano, anticè porrecto, apice truncato arcuato. Caput subtùs parte anticâ tumidâ; clypeo deflexo, labro ad apicem ejus affixo. Mandibulæ angustæ, fere similes, apice acuto denteque parvo subapicali armatæ. Prothorax anticè lævis, nitidus; lateribus punctatis et utrinque fossulâ rotundatâ instructus; disco ante medium carinâ tenui transversâ (in medio interruptâ) canalique tenui punctato longitudinali pone medium ante marginem posticum obliterato. Elytra striato-punctata; striis 14 in singulo elytro ad apicem elytrorum extensis. Tibiæ anticæ dentibus 6 nigris extùs armatæ.

Fig. 2 *a*, caput et pronotum supra visa; 2 *b*, caput a latere; 2 *c*, labrum; 2 *d*, mandibulæ; 2 *e*, maxilla*; 2 *f*, laciniæ labii cum palpis labialibus.

This appears to be the insect given by Mr. MacLeay as the female of *Elephastomus proboscideus*. It is however a male, and is given by Dr. Klug as a variety of the male of that species. The insect above described appears, however, to me to be sufficiently distinct as a species from the former †.

3. Bolboceras Reichii; castaneus nitidus, capite cornu valdè elongato erecto, prothorace anticè valdè deflexo et subconcavo cornubus duobus crassis longitudine capitis porrectis lateralibus anticè armato: singulo versus basin dente obtuso erecto instructo; prothoracis lateribus rudè punctatis spatioque triangulari impresso et punctato ante scutellum; margine postico parùm elevato, elytris striis gracillimis punctatis, tibiis

* The upper division of the inner lobe is multispinose; Dr. Klug has represented it as distinctly bifid in both sexes of *B. Australasiæ*.

† The variety of the preceding species, wanting the perpendicular horn in front of the mouth, received since this sheet has been in type, seems to confirm Dr. Klug's opinion.

anticis extùs 5-dentatis. ♂.—Long. corp. lin. 11; lat. prothoracis lin. 7. (Tab. III. fig. 3.)

Hab. Port Essington. In Muss. *Hope* et *Reiche.*

♂ *Bolb. Reichii*, Guérin, Voyage de la Favorite, p. 50, et Iconogr. du Règne Anim., Ins. p. 84.

Bolb. Kirbii ♂, Hope in Proc. Ent. Soc., Nov. 1841, p. 43.

♀ *Bolb. Kirbii*, Bainbridge in Trans. Ent. Soc. vol. iii. p. 79.

Fœmina differt capite minori; vertice in tuberculum conicum apice bifidum elevato; clypeo et vertic carinâ tenui angulatâ separatis; pronoto anticè spatio subhexagono plano polito, in puncta duo profunda anticè lateraliter desinente, disco pone medium valdè punctato, versus marginem posticum elevato lævi, spatio ovali mediano punctato et impresso relicto.—Long. corp. lin. 11.

Hab. ad Melville Island. Mus. *Hope* (etiam in Mus. *Gory*, nunc *Hope*, cum nomine *B. Reichii* inscriptus).

Fig. 3, mas magnit. naturalis; 3 *a*, caput suprà visum; 3 *b*, caput et prothorax a latere visa; 3 *c*, mandibulæ maris; 3 *d*, caput et prothorax fœminæ suprà visa; 3 *e*, eadem a latere visa.

Obs. The name given to the male of this species is here retained in preference to that of the female, in accordance with the usual custom in such cases.

4. Bolboceras serricollis, Bainbridge, Trans. Ent. Soc. vol. iii. p. 80. ♂.

Bolb. frontalis, Klug, Mon. Ath. et Bolb. p. 21. tab. 2. fig. 7 & 7*a*. (♂ ♀)

♀ *Bolb. latus*, Bainbridge, op. cit. vol. iii. part 2. p. 80.

♀ *Bolb. frontalis*, Guérin, Ins. Voy. Favorite, Mag. Zool. 1838, p. 51; Klug, tab. supr. cit. fig. 7 *b, c*.

Hab. ad Swan River. Mus. *Hope.*

5. Bolboceras hastifer, Bainbridge, op. cit. p. 81. ♂.

Athyreus recticornis, Guérin, Ins. Voy. Favorite, Mag. Zool. 1838, p. 49. pl. 232. fig. 1.

Bolb. recticornis, Klug, op. cit. p. 23. tab. 2. fig. 8.

Var. ♂ *Bolb. fissicornis*, Bainbridge, op. cit. p. 82.

Differt cornubus capitis et pronoti parùm brevioribus, hoc parùm crassiori et apice fisso.

Fig. 4 *a*, caput et pronotum hujus varietatis maris suprà visa; 4 *b*, eadem a latere; 4 *c*, pars anterior capitis a latere; 4 *d*, mandibulæ.

Hab. ad Swan River.

6. Bolboceras 3-tuberculatus, Bainbridge, op. cit. p. 82. ♂.

Bolb. trituberculatus, Klug, op. cit. p. 24. no. 7.

Bolb. thoracicornis, Gory, MS. in Mus.

Bolb. Guerini, Reiche, MS.

Fig. 5 *a*, caput et prothorax maris suprà visa; 5 *b*, mandibulæ maris; 5 *c*, caput et prothorax fœminæ suprà visa; 5 *d*, eadem a latere.

Hab. ad Swan River.

Obs. Mr. Bainbridge mistook the porrected closed mandibles of the male for the clypeus; his description, "clypeus quadridentatus medio emarginatus," being drawn from the mandibles. The female was sent me from Paris for examination by M. Reiche.

7. Bolboceras 7-tuberculatus, Bainbridge, op. cit. p. 81. ♂.

Bolb. excavatus, Klug, op. cit. p. 23. tab. 2. fig. 9. ♂.

Hab. ad Swan River.

Insectum hic describam, in Mus. *Goryi* olim conservatum, cum nomine manuscripto "*Bolb. transversus*, Gory" inscriptum. Hoc insectum *Bolb. 7-tuberculati* fœmineum existimavi, corpus totum fulvo-

castaneum; capite et pronoto punctatis; clypei margine antico recto simplici, posticè tuberculis 4 e vertice separato, tuberculis duobus intermediis approximatis et paullò anterioribus, angulis lateralibus ante oculos acutis et parum reflexis. Pronotum impressione parvâ oblongâ in medio marginis antici; disco transversim bicarinato, carinis lateraliter convergentibus spatium transversum subconcavum includentibus; impressione parvâ ovali nigricanti utrinque versus angulos posticos. Elytra lævia, striis gracillimis punctatis. (Tab. III. fig. 6 *a*, caput et prothorax suprà visa; 6 *b*, eadem a latere.)

Obs. Bolb. 7-tuberculatum fœminam *Bolb. hastiferi* esse autumat D. Reiche.

8. Bolboceras coronatus; "testaceus, capite punctato anticè medio 5- posticè utrinque 1-tuberculato, thorace rugoso, posticè transversim bicarinato dorso tuberculato, elytris punctato-striatis."—Long. lin. 9.

Bolb. coronatus, Klug, op. cit. p. 22. tab. 2. fig. 10, 10 *a*.

Hab. ad litt. occid. Novæ Hollandiæ. In Mus. *D. Hope* individuum pinguedine saturatum vidi.

9. Bolboceras quadricornis; "capite bicorni, thorace dorso cornubus duobus divaricatis armato lateribus profundè excavato, rufus, elytris nigris."—Long. corp. lin. 7½.

Bolb. quadricornis, Klug, op. cit. p. 22. tab. 2. fig. 6.

Hab. ad litt. occid. Novæ Hollandiæ; a me haud visus.

10. Bolboceras Taurus; castaneus nitidus, capitis vertice utrinque laminis duabus auriculatis erectis instructo cornubusque duobus elongatis curvatis nigris ante oculos armato, pronoto in medio versus marginem anticum parùm reflexo seu tuberculis duobus transversis subelevatis instructo; lateribus punctatis.—Long. corp. lin. 8. (Tab. III. fig. 7.)

Bolb. Mimax, Reiche, MS.

Hab. ad Swan River. In Mus. *Hope* (olim *Gory*) sub nomine manuscripto hic conservato; etiam in Mus. *Saunders*.

Corpus suprà castaneum nitidum, pro latitudine parùm magis elongatum. Caput sub lente granulosum, tuberculis duobus erectis angulatis inter oculos; verticis medio carinâ curvatâ parùm elevatâ utrinque in cornu porrectum curvatum nigrum (longitudine caput æquans) desinente. Clypeus declivis, granulosus. Mandibulæ parvæ, apice bidentatæ, dextræ margine externo magis rotundato, et ante apicem inciso. Antennæ, partes oris, et caput infrà fulvæ. Pronotum lateribus marginatis ciliatis et serrulatis, utrinque intra angulum anticum profundè impressum, anticè in medio versus marginem anticum glabrum et parùm elevatum, parte elevatâ in duas partes lineâ longitudinali impressâ divisâ, lateribus obliquè elevatis, rudè punctatis, et impressione rotundatâ parùm profundâ intra angulos posticos instructis. Elytra valdè convexa striis 7 punctatis ordinariis inter suturam et tubercula humeralia; lateribus etiam punctato-striatis. Scutellum læve. Pedes crassi. Tibiæ anticæ extùs dentibus 5 obtusis armatæ.

Fig. 7 *a*, insectum magnitudine parùm auctum; 7 *b*, caput et prothorax a latere visa; 7 *c*, mandibulæ.

11. Bolboceras capreolus; castaneus nitidus, capite posticè nigricanti; vertice cornu lato furcato 6-dentato erecto armato, pronoto anticè retuso glabro, dorso carinâ transversâ pone medium instructo, mandibulis magnis extùs denticulatis. ♂.—Long. corp. lin. 9. (Tab. III. fig. 8.)

Bolb. diadematus, Reiche, MS.

Hab. in Novâ Hollandiâ, Swan River. In Mus. *Hope* (olim Mus. *Gory*), cum nomine suprà conservato designatum. Fœmina in Mus. *D. Reiche*.

Corpus suprà castaneum nitidum. Caput labro porrecto, clypei margine antico tenui elevato in medio tuberculo minuto instructo; frons glaberrima concava, suprà in medio verticis in cornu latum elevata, cujus apex anticè in dentes 4 acutos desinet, dentibusque duobus majoribus posticis versus pronotum inclinatis. Mandibulæ magnæ, porrectæ, concavæ, difformes; singula ante apicem externè in dentem porrectum subacutum elongata. Antennarum clava lutea. Prothorax elytris latior, anticè declivis nitidissimus et gläberrimus lineâque parùm impressâ longitudinali medianâ, carinâ transversâ utrinque abbreviatâ pone medium disci extensâ, pronoti parte posticâ lateribusque punctatis, his versus angulos posticos utrinque impressione ovali instructis. Elytra nitida tenuissimè punctato-striata, striis ante apicem desinentibus. Tibiæ anticæ 6-dentatæ, dentibus externis magnis acutis.

Fig. 8 *a*, mas magnitudine parùm auctus; 8 *b*, prothorax et caput a latere visa; 8 *c*, mandibulæ maris; 8 *d*, cornu verticale; 8 *e*, prothorax et caput fœminæ a latere visa.

12. Bolboceras neglectus, Hope, Proc. Ent. Soc. Nov. 1, 1841, p. 43.

Fœmina sub hoc nomine in Mus. *D. Hope* hospitatur, Portûs Essingtonii, Novæ Hollandiæ, incola, quæ cum *B. Reichii* ♀ fere congruit, nisi magnitudine minori (lineas 9 tantùm longitudine habens) spatioque ovali depresso punctato ante scutellum carente; structurâ capitis, parteque politâ anticâ pronoti pone oculos in puncta duo magna profunda desinente, cum specie prædictâ convenit. An ejus varietas minor vel fœmina speciei alteræ?

Fig. 9 *a*, caput et prothorax suprà visa.

13. Bolboceras Bainbridgii; piceus, capitis clypeo anticè tridentato: dente intermedio minori; vertice inermi, pronoto anticè valdè declivi dente erecto versus marginem anticum; parte declivi suprà carinâ curvatâ marginatâ.—Long. corp. lin. 7. (Tab. III. fig. 10.)

Hab. in Novâ Hollandiâ, ad Swan River. In Mus. *D. Hope.*

Præcedentibus minor. *B. hastifero* magis affinis, differt verò capite anticè tridentato. Caput suprà planum; vertice fere lævi et inermi; clypeo anticè declivi suprà in lineam bisinuatam desinente, dentes tres efformante quorum laterales majores et magis porrecti. Mandibulæ difformes, dextra ante apicem externè lobo subrotundato instructa. Prothorax punctatus, punctis in medio disci magis remotis; parte anticâ valdè declivi, medio versus marginem anticum dente brevi erecto armatâ, et posticè lineâ curvatâ vel carinâ arcuatâ e parte posticâ separatâ: utrinque versus angulos posticos impressione rotundatâ instructus. Elytra punctato-striata, striis satis distinctis, sed ante apicem evanescentibus. Tibiæ anticæ extùs 6-dentatæ, dentibus duobus anticis (in specimine nostro unico) obliquè truncatis.

Fig. 10 *a*, mas magnitudine parùm auctus; 10 *b*, caput et prothorax e latere visa; 10 *c*, mandibulæ.

Named in remembrance of the late Mr. W. Bainbridge, an assiduous collector of English insects, by whom descriptions of some Australian species of this genus were published in the 3rd volume of the Transactions of the Entomological Society of London.

14. Bolboceras rotundatus; parvus rotundatus rufo-castaneus glaberrimus, clypeo tuberculo elevato alteroque in medio verticis inter oculos, pronoto convexo vix punctato punctis paucis et valdè distantibus lineâque longitudinali medianâ impressâ punctatâ.—Long. corp. lin. 4. (Tab. III. fig. 11.)

Bolb. rotundatus, Hope in Proc. Ent. Soc., Nov. 1, 1841, p. 43.

Hab. in Novâ Hollandiâ, ad Port Essington. In Mus. *D. Hope.*

Præcedentibus multò minor et ferè rotundatus. Corpus suprà glaberrimum convexum vix punctatum. Caput suprà in medio tuberculo (vel potius tuberculis duobus parvis conjunctis) instructum, margine

antico in tuberculum elevato, lineis 4 elevatis ex hoc tuberculo prodeuntibus, scil. duabus ad angulos clypei anticos, duabusque ad basin antennarum; angulis 2 ante oculos rotundatis; parte capitis anteriori punctatâ. Mandibulæ difformes; dextra ut in multis aliis speciebus, lobo externo ante apicem instructa. Prothorax lineâ parùm impressâ longitudinali medianâ punctatâ, lateribus etiam versus angulos posticos impressionibus duabus rotundatis instructis. Elytra punctato-striata; striis ad apicem elytrorum extensis. Pedes antici longiores; tibiæ anticæ extùs 5-dentatæ.

Fig. 11 *a*, caput et prothorax suprà visa; 11 *b*, mandibulæ.

15. Bolboceras rubescens; fulvo-rufus glaberrimus, clypeo integro e vertice lineâ elevatâ separato, vertice tuberculis duobus minimis, prothorace convexo nitidissimo vix punctato; canali abbreviato in medio marginis antici punctisque nonnullis in lineam longitudinalem posticam dispositis fossulâque rotundatâ utrinque impressâ instructo. —Long. corp. ferè lin. 3. (Tab. III. fig. 12.)

Bolb. rubescens, Hope, in Proc. Ent. Soc., Nov. 1, 1841, p. 43.

Hab. ad Port Essington Novæ Hollandiæ. In Mus. *Hope.*

B. rotundato valdè affinis; differt magnitudine minori, colore pallidiore, lineâque impressâ pronoti ferè obliteratâ.

Fig. 12 *a*, caput et prothorax suprà visa.

16. Bolboceras corniculatus; rotundatus rufus glaberrimus, verticis margine antico ferè recto in medio subtuberculato; disco convexo utrinque inter oculos cornu erecto triangulari armato, pronoto sparsim punctato cornubus duobus contiguis versus marginem anticum tuberculisque duobus conicis lateralibus armato medioque fossulâ parvâ longitudinali, elytris striato-punctatis.—Long. corp. lin. 3. (Tab. III. fig. 13.)

Bolb. corniculatus, Reiche, MSS.

Hab. ad Swan River Novæ Hollandiæ. In Mus. *D. Reichii*, Parisiis.

Parvus, rotundatus, rufus; elytris magis fulvis. Caput castaneo-rufum, suprà valdè concavum glaberrimum; verticis margine antico subrecto, tuberculo minuto medio instructo, ejusdem angulis anticis subacutis, utrinque etiam prope marginem oculorum internum spinâ conicâ erectâ armato. Antennæ fulvæ. Pronotum valdè convexum, glaberrimum, tenuissimè marginatum, punctis paucis notatum; cornubus duobus contiguis apice obtusis prope marginem anticum, spatio transverso pone cornua impresso utrinque in tuberculum conicum desinente, dimidio postico, fossulâ tenui mediâ longitudinali punctatâ impresso, utrinque etiam versus marginem lateralem impressione parvâ rotundatâ punctatâ notato. Elytra glabra, valdè convexa; singulo striis decem punctorum, tribus externis cum tribus suturæ magis approximatis ad apicem conjunctis, intermediis abbreviatis. Pedes castaneo-rufi; tibiæ anticæ extùs 6-dentatæ, dentibus obtusis, calcari anticarum elongato gracili, apice obtuso. An *B. rotundati* mas?

Fig. 13 *a*, caput et prothorax suprà visa; 13 *b*, eadem a latere visa.

Stenaspidius, Westw. Subgenus novum.

Corpus magis elongatum quam in *Bolboceratis veris*; scutello elongato (nec triangulari); elytris striis tantùm quinque inter humeros et suturam; mesosterno porrecto. Differt etiam colore antennarum.

17. Bolboceras (Stenaspidius) nigricornis; ovalis niger nitidus sparsim punctatus, capite tuberculo conico inter oculos, pronoto canali punctato medio aliisque duobus

abbreviatis pone oculos, elytris striato-punctatis.—Long. corp. lin. 3½. (Tab. III. fig. 14.)

Hab. in Novâ Hollandiâ. In Muss. *D. Hope* (olim *Gory,* cum nomine suprà indicato inscripto), *Reiche* et *Westw.*

Corpus suprà nigrum, nitidum. Caput mediocre. Clypeus e vertice lineâ elevatâ vel carinatâ in medio parùm angulatâ divisus, lineisque duabus brevioribus ad angulos posticos labri extensis. Antennæ nigræ; articulis parvis intermediis piceis. Mandibulæ ut in plurimis, dextra ante apicem externè lobo rotundato corneo instructa. Vertex tuberculo elevato inter oculos instructus; angulisque ante oculos rotundatis. Prothorax convexus, sparsim punctatus, lineâ longitudinali medianâ punctatâ impressâ alterisque duabus e margine antico pone oculos obliquè extensis at abbreviatis spatioque utrinque angusto parùm elevato, lævi, cum margine postico ferè parallelo, in fossulas 2 obliquas parùm profundas versus angulos posticos prothoracis desinente. Elytra striato-punctata, striis 5 inter humeros et suturam, aliisque 4 lateralibus. Tibiæ anticæ extùs 5-dentatæ. Scutellum elongato-triangulare. Mesosternum parùm angulato-porrectum.

Fig. 14 *a*, insectum magnitudine auctum; 14 *b*, caput, prothorax et mesosternum, a latere visa; 14 *c*, clypeus cum labro et mandibulis.

EXPLANATION OF THE FIGURES.

Tab. III.

Fig. 1. *Bolboceras* (*Elephastomus*) *proboscideus*, MacL.
Fig. 2. *Bolboceras* (*Elephastomus*) *Kirbii*, Hope.
Fig. 3. *Bolboceras Reichii*, Guér.
Fig. 4. *Bolboceras hastifer*, Bainbr. *var.*
Fig. 5. *Bolboceras 3-tuberculatus*, Bainbr.
Fig. 6. *Bolboceras 7-tuberculatus*, Bainbr. ♀?
Fig. 7. *Bolboceras Taurus*, Gory.
Fig. 8. *Bolboceras Capreolus*, Gory.
Fig. 9. *Bolboceras neglectus*, Hope.
Fig. 10. *Bolboceras Bainbridgii*, Westw.
Fig. 11. *Bolboceras rotundatus*, Hope.
Fig. 12. *Bolboceras rubescens*, Hope.
Fig. 13. *Bolboceras corniculatus*, Reiche.
Fig. 14. *Bolboceras* (*Stenaspidius*) *nigricornis*, Westw.

IV. *Descriptions of some new or imperfectly known Species of* Bolboceras, *Kirby.*

By J. O. Westwood, *Esq., F.L.S.*

Read June 6, 1848.

Having in two previous communications described a number of new species of *Athyreus*, chiefly from South America, and given a synopsis of the Australian species of *Bolboceras*, I shall on the present occasion continue the descriptions of the species of the latter genus, especially such as are natives of the East Indies.

With the view of showing the generic as well as sexual distinctions existing between the *Bolbocerata* and *Odontæi*, I have given figures of the head and front of the prothorax of both sexes of *Odontæus mobilicornis* and *Bolboceras Æneas*, Pz. (*quadridens*, Dftschm.) from Austria, together with the side of the head (showing the eyes), maxillæ and fore femora of both these insects. (Tab. IV. fig. 1 & 2, with the details.)

1. Bolboceras Cyclops, Fabr. Ent. Syst. i. p. 15; Oliv. Ent. i. 3. t. 15. f. 140; ferrugineus, clypeo anticè carinâ transversâ tuberculisque duobus acutis instructo, vertice lineâ tenui parùm elevatâ inter oculos, pronoto utrinque excavatione profundâ subrotundâ anticè cornu acuto alteroque minori versus medium armato; spatio inter cornua intermedia plano punctato; anticè lineâ semicirculari parùm elevatâ cincto canali vix distincto longitudinali ante scutellum terminato, elytris punctato-striatis striis tenuibus, tibiis anticis 8-dentatis. (Mas.)—Long. corp. lin. 9. (Tab. III. fig. 15.)

Variat mas magnitudine cornuum capitis et pronoti necnon profunditate excavationum hujus lateralium.

Hab. in Javâ, Assam, et Indiâ centrali. Muss. *Hope* (olim *Lee*) et nostr. (*Hearsey*).

Fig. 15, insectum magnitudine paullò auctum; 15 *a*, caput et prothorax lateraliter visa.

Obs. The figure and description are made from the original specimen described from Lee's Collection by Fabricius, now in the Cabinet of the Rev. F. W. Hope.

2. Bolboceras grandis, Hope MSS.; rufo-castaneus, capite dentibusque tibiarum anticarum nigricantibus, clypeo carinâ tenui semicirculari, vertice carinâ transversâ inter oculorum partem anticam, pronoto convexo carinâ semicirculari tuberculisque duobus versus marginem anticum lineâque tenui longitudinali impressâ mediâ in parte posticâ. (Fœm.)—Long. corp. lin. 9. (Tab. IV. fig. 3, caput et prothorax suprà visa.)

Hab. in Indiâ orientali? In Mus. *D. Hope.*

Caput suprà sub lente granulosum, mandibula dextra extùs ante apicem incisa, pronotum anticè punctatum, posticè læve nitidum, versus angulos posticos utrinque parùm impressum. Elytra tenuissimè punctato-striata, striis ad apicem elytrorum extensis. Tibiæ anticæ 7-dentatæ. Corpus subtùs concolor, pilis fulvis hirtum.

Individuum e Calcutta vidi (pro fœminâ sp. præcedentis, *B. Cyclops*, e Parisiis, a Domino Chevrolatio mihi transmissum) in quo carina antica clypei magis recta et transversa evadit, lineaque impressa

pone carinam verticalem; prominentiis in parte anticâ pronoti minùs distinctis, lineâque longitudinali posticâ obliteratâ; capiteque corpori concolori.—Long. corp. lin. $7\frac{1}{2}$.

Obs. Captain Parry possesses a rather smaller specimen, with the central impressed longitudinal line of the prothorax less distinct, the lateral tubercles near its anterior angles not so large, but covered with minute punctures, as is also the front of the prothorax, and the front of the head has the angles more emarginate.

3. Bolboceras subglobosus *, Westw.; ferè globosus castaneo-rufus, capite et pronoto punctatissimis, margine capitis elevato, clypei margine antico recto carinâque transversâ inter oculos, pronoto carinâ curvatâ prope marginem anticum. (Fœm.)—Long. corp. lin. $8\frac{1}{2}$. (Tab. IV. fig. 4, caput et prothorax suprà visa.)

Hab. in Indiâ orientali. *D. Boys*, in Mus. *Westw.*

B. grandi valdè affinis at magis globosus, capite et pronoto magis granulato-punctatis. Caput latum, carinâ rectâ transversâ ad basin clypei alterâque abbreviatâ rectâ inter partem anticam oculorum. Mandibulæ latæ, dextra ante apicem profundè incisa, lateribus tenuibus, recurvis, nigris. Pronotum versus marginem posticum parùm lævius, carinâ curvatâ medianâ prope marginem anticum, tuberculisque duobus elevatis et sublævibus inter carinam et angulos anticos, et impressione circulari parùm profundâ et sublævi in medio lateris utriusque. Elytra lævia, gracillimè striato-punctata. Tibiæ anticæ latæ, dentibus 7 nigris obtusis.

The insect which has served for the above description appears to be a female, and is closely allied to the preceding. I am unable, however, to surmise whether the male is one of those described in the subsequent portion of this memoir, or is still unknown.

4. Bolboceras furcicollis, De Laporte, An. Art. Coleopt. vol. ii. p. 104. No. 3; castaneo-rufus sub lente granulosus, clypeo maris quadrato plano anticè bisinuato angulis lateralibus anticis in cornua duo porrectis, pronoto posticè elevato; disco in medio cornubus duobus erectis distantibus recurvis alterisque duobus intùs concavis versus angulos posticos; canali lævi mediano versus marginem posticum, elytris punctato-striatis, tibiis anticis extùs 6-dentatis.—Long. corp. lin. 10. (Tab. III. fig. 16, 17.)

B. Lecontei, Dej. Catal. Coleopt. p. 149.

Differt mas longitudine et magnitudine cornuum clypei et pronoti.

Hab. in Americâ boreali (test. *De Laporte* et Muss. *Hope* et *Gory*) an recte?

Obs. Mr. Melly possesses a specimen exactly agreeing with the male in Mr. Hope's Collection, figured above, which he received from Comercolly, in the East Indies. He also possesses a second specimen, from Thibet, very slightly smaller, having the cornuted processes on the prothorax very slightly smaller, the space between the two porrected points of the clypeus nearly straight, and not sinuated, agreeing in its colour with Mr. Hope's Assamese specimen of *B. Cyclops*, except that of the tips of the spines of the fore-legs and of the pronotum and clypeus, which are black. A third specimen is also in Mr. Melly's Collection, from Thibet, of an intermediate colour, exactly agreeing with them in general character and punctation, but having the anterior angles of the clypeus very slightly por-

* This species, as well as Nos. 9, 22, 24, 25, 26 and 27, have been added subsequently to the reading of the paper.

rected, the two horns of the pronotum much smaller, and the conical tubercle on each side scarcely evident, appearing as a slight carina.

Fig. 16, insectum suprà visum; 16 *a*, caput et prothorax a latere visa; 17 *a*, caput et prothorax individui alteri masculi suprà visa; 17 *b*, eadem a latere; 17 *c*, labrum cum mandibulis.

5. Bolboceras ferrugineus, De Laporte, Hist. Nat. An. Art. Col. vol. ii. p. 104. No. 4; castaneo-fulvus sub lente granulosus, capite anticè carinâ sinuatâ anticâ tuberculoque subbifido transverso inter oculos, pronoto ante medium spatiis duobus parùm elevatis lævibus lineâ tenui impressâ punctatâ (ferè ad marginem posticum extensâ) divisis utrinque etiam versus angulos posticos impressione obliquâ suprà carinâ lævi marginatâ, elytris punctato-striatis, tibiis anticis 6-dentatis.—Long. corp. lin. 9½. (Tab. III. fig. 18, caput et prothorax suprà visa; 18 *a*, mandibulæ.)

Hab. in Indiâ orientali? In Mus. *Gory* (nunc *Hope*).

Obs. M. Gory's specimen, from which Count De Laporte drew his description, is now in Mr. Hope's Collection before me, bearing a label, "*Bolboceras ferrugineus*, Fabr., Ind. or." Fabricius, however, described no *Scarabæus* under such a name, whilst the *Scarabæus ferrugineus* of Olivier (Ins. 1. Gen. 3. p. 148. pl. 23. fig. 202) does not belong even to the present genus, and is from Senegal. It is possible that it may prove to be the other sex of *B. furcicollis*, De Lap.

6. Bolboceras carinicollis, De Laporte, Hist. Nat. An. Art. Coleopt. vol. ii. p. 104. No. 2; *B. ferrugineo* affinis sed magis castaneus, sub lente granulosus, capite carinâ tenui marginali curvatâ verticeque tuberculis duobus parvis conicis inter oculos carinâ connexis, pronoto obscuro in medio carinâ transversâ abbreviatâ instructo maculâque nigrâ utrinque versus angulos posticos, elytris striatis striis punctis minutis, tibiis anticis 5-dentatis.—Long. corp. lin. 10. (Tab. IV. fig. 5, caput et prothorax suprà visa.)

Hab. in Indiâ orientali? In Mus. *Gory* (nunc *Hope*).

7. Bolboceras Calanus, Hope MSS.; fulvus vel rufo-castaneus, clypeo posticè bicornuto, prothorace cornubus 4 versus marginem anticum duobus intermediis contiguis et a reliquis cavitate rotundatâ utrinque separatis.—Long. corp. lin. 7–8½. (Tab. III. fig. 19; IV. fig. 6, 7.)

Hab. in Indiâ orientali, Bombay. In Muss. *Melly* et *Hope*.

Variat colore, interdum luteo-fulvus, interdum rufo-castaneus; vertice concavo, parte anticâ tuberculis duobus elevatis armatâ, posticè lineâ vix elevatâ et in medio interruptâ instructâ. Prothorax dorso vix punctato, lateribus punctulatis, versus marginem anticum cornubus 4 armatus; duo contigua elevata subobtusa, alterisque duobus lateralibus majoribus, e prioribus utrinque excavatione plùs minùsve profundâ separatis; canali tenui longitudinali mediano. Elytra tenuissimè punctato-striata. Tibiæ anticæ 7-dentatæ; dentibus plùs minùsve acutis.

Fœmina? Rufo-fulva nitida; capite et lateribus pronoti punctatissimis, hujus disco et parte posticâ ferè impunctatis. Clypeus margine postico acutè elevato et parùm curvato, carinâque parùm arcuatâ inter oculos instructus. Pronotum anticè vix retusum carinâ curvatâ parùm distinctâ versus marginem anticum, utrinque tuberculo parvo lineâque impressâ medianâ ad marginem posticum extensâ.

Tibiæ anticæ subangustæ 7-dentatæ, dentibus externis acutis, elongatis, curvatis, denticulisque pedum posticorum apice nigris.—Long. corp. lin. 7.

Hab. in Indiâ orientali. *D. Boys*, in Mus. *Westw.*

Fœminæ var.? (*B. tumidulus*, Westw.) Obscurè castaneo-rufa, carinis transversis ut in præcedenti nigris; parte capitis posticâ tumidulâ. Pronotum anticè vix retusum, glabrum, lateribus lineâque longitudinali impressâ punctatis; spatio parvo medio antico lævissimo, utrinque impressione parùm profundâ e lateribus pronoti separato; tibiis anticis spinis 7 robustis armatis.—Long. corp. lin. 6.

Hab. in Indiâ orientali, Borhendshukur. *D. Bacon*, in Mus. *Laferte.*

Tab. III. fig. 19, mas magnitudine paullò auctus; 19 *a*, caput et prothorax a latere visa; 19 *b*, clypeus, labrum et mandibulæ maris. Tab. IV. fig. 6, caput et prothorax fœminæ suprà descriptæ; 7 *a*, caput et prothorax fœminæ varietatis suprà descriptæ; 7 *b*, eadem a latere visa.

8. Bolboceras lævicollis, Westw.; fulvo-castaneus, vertice ante medium bidentato, prothorace glabro tuberculis 4 versus marginem anticum æquidistantibus duobus intermediis carinâ tenui curvatâ conjunctis.—Long. corp. lin. 9½. (Tab. IV. fig. 8, caput et prothorax.)

Hab. in Indiâ orientali. In Mus. *Hope.*

Corpus suprà fulvo-castaneum, capite obscuriori; clypeo lineâ tenuissimâ elevatâ omninò circumcincto; vertice concavo, ante medium tuberculis duobus acutis erectis armato. Prothorax convexus, lævis, nitidus, ante medium tuberculis 4 acutis armatus, æquidistantibus, intermediis duobus lineâ tenui (versus caput curvatâ) elevatâ conjunctis, spatio inter hæc et lateralia utrinque parùm concavo; canali tenui longitudinali in parte posticâ politâ. Elytra tenuissimè punctato-striata. Tibiæ anticæ dentibus 8, duobus anticis multò majoribus.

9. Bolboceras punctatissimus, Westw.; fulvus punctatissimus, capite tuberculis duobus transversis inter antennarum basin, pronoto vertice parum retuso, parte anticâ lunulâ subelevatâ medianâ transversâ e posticâ separatâ.—Long. corp. lin. 4. (Tab. IV. fig. 9.)

Hab. in Indiâ orientali, Moradabad, vespere ad lumen volans. *D. Bacon*, in Mus. *D. Laferte.*

B. lævicolli affinis, omnino flavescenti-fulvus, margine tenuissimo capitis et pronoti et apicibus tuberculorum capitis castaneis. Caput et pronotum punctatissima. Vertex tuberculis duobus parvis rotundatis transversis inter antennarum basin; lateribus capitis inter antennas et oculos rotundatis. Pronotum anticè subretusum, punctatissimum; parte retusâ e posticâ lunulâ curvatâ separatâ lineâque parùm profundè impressâ pone lunulam versus marginem posticum ductâ impressionibusque duabus parvis lateralibus; scutellum et elytra punctis minutis notata, his striato-punctatis; striæ secundæ e suturâ parte quartâ posticâ obliteratâ, lateribus elytrorum magis rugosis striisque lateralibus minùs distinctis. Subtùs pallidior, pilis longis flavis obsitus. Tibiæ anticæ dentibus 7 acutis armatæ.

Fig. 9, caput et prothorax suprà visa; 9 *a*, eadem a latere.

10. Bolboceras lateralis, Westw.; castaneus, capite pedibusque nigricantibus, capite inermi, prothorace ferè lævi; excavationibus duabus lateralibus rotundatis singulâ suprà tuberculo acuto armatâ.—Long. corp. lin. 6. (Tab. IV. fig. 10, caput et prothorax.)

Hab. in Indiâ orientali, Gogo. In Mus. *Hope.*

Caput nigrum, sub lente punctatum, suprà inerme, angulis clypei anticis tuberculo rudimentali instructis, verticeque inter oculos lineâ vix elevatâ transversâ. Prothorax convexus, ferè lævis, lateribus prope angulos posticos excavatione rotundâ tuberculoque conico suprà armatis, lineâque tenuissimâ canaliculatâ in medio instructus. Elytra tenuissimè punctato-striata. Tibiæ anticæ 9-dentatæ, dentibus obtusis.

11. Bolboceras nigricans, Westw.; piceo-niger nitidus, clypeo tuberculo conico anticè armato, verticis marginibus lateralibus utrinque bituberculatis discoque carinâ elevatâ inter oculos instructo, prothorace glabro nitido anticè retuso 4-dentato dentibus subæquidistantibus.—Long. corp. lin. 6. (Tab. IV. fig. 11, caput et prothorax.)

Hab. in Bengaliâ. In Mus. *Hope.*

Affinis *B. 4-dentato* e quo differt armaturâ capitis. Corpus suprà nigricans vel nigro-piceum, nitidum, parùm punctatum. Capitis vertex inter oculos carinâ elevatâ, suprà parùm sinuatâ; margineque antico 5-tuberculato, tuberculo medio antico majori acuto. Prothorax paullò ante medium disci 4-dentatus, dentibus brevibus subæquidistantibus, utrinque etiam versus angulos posticos impressione parvâ instructus. Tibiæ anticæ extùs 5-dentatæ.

12. Bolboceras politus, Westw.; nitidus fulvus, capite et pronoto magìs castaneis, capite anticè tricorni cornu antico majori erecto, prothorace excavatione maximâ dorsali posticè trisinuatâ, elytris punctato-striatis, tibiis anticis 5-dentatis dentibus anticis magnis acutis.—Long. corp. lin. $6\frac{1}{2}$. (Tab. IV. fig. 12.)

Hab. in Senegaliâ. In Mus. *Hope* (olim *Gory* nomine '*Athyreus porcatus*, Lap., *Senegalensis*, Dej.,' haud rectè inscriptus).

Corpus suprà nitidum, caput vertice subconcavo, clypeo tricorni, cornu antico suberecto et majori, lateribus ante oculos rotundatis. Mandibulæ difformes; dextra apice obtuso intùs dente duplici armato; sinistra pone medium marginis externi angulata, apice obliquè truncato. Antennæ luteo-fulvæ. Prothorax nitidissimus, remotè punctatus, excavatione magnâ e margine antico ferè ad scutellum extensâ: margine ejus postico trisinuato; excavatione parvâ utrinque versus angulos laterales prothoracis. Elytra brevia, luteo-fulva, punctato-striata; striis 7 inter humeros et scutellum aliisque lateralibus. Tibiæ anticæ acutè 5-dentatæ.

Individuum parvum (lin. $5\frac{1}{2}$ long.) e Prom. Bonæ Spei in Mus. *Chevrolat* Parisiis vidi.

Fig. 12, insectum magnitudine paullò auctum; 12 *a*, caput et prothorax a latere visa.

13. Bolboceras Coryphæus, Fabr. Ent. Syst. i. p. 9; Oliv. Ent. i. 3. tab. 16. f. 150; rufo-fulvus, capite suprà plano, clypeo anticè bicorni cornubus recurvis apice nigris posticèque mucrone elevato brevissimo nigro, pronoto anticè retuso cornubus duobus brevibus approximatis anticè porrectis apice nigris in medio disco positis posticè gibbere obtuso in excavatione parùm profundâ instructo, elytris punctato-striatis, tibiis anticis 5-dentatis.—Long. corp. lin. 8. (Tab. IV. fig. 13.)

Hab. ad Cap. Bonæ Spei (teste Fabricio). In Mus. *Hope* (olim *Lee*).

Fig. 13, insectum magnitudine vix auctum; 13 *a*, caput et prothorax a latere visa.

Obs. My figure and description are derived from Lee's typical specimen described by Fabricius, now in Mr. Hope's Cabinet.

14. Bolboceras scabricollis, Chevrol. MS.; ferrugineus, capite et pronoto magis piceis, his punctis minutis plus minusve confluentibus scabriusculis, capite in medio carinâ brevi transversâ sub-3-lobatâ, pronoto impressionibus tribus longitudinalibus ferè obliteratis.—Long. corp. lin. 8.

Hab. apud Caput Bonæ Spei. In Mus. *Dom. Chevrolat.*

B. Capensi, Klug, multò major magisque punctatus. Caput undique margine tenui elevato, disco punctato, verticeque in medio carinâ brevi transversâ quasi e tuberculis tribus conjunctis, armato; mandibulæ extùs regulariter rotundatæ. Antennæ rufæ. Pronotum piceo-ferrugineum, punctatum,

impressione ferè indistinctâ utrinque ad marginem anticum (pone oculos), alterâque longiori mediâ, quæ in lineam tenuissimam longitudinalem elevatam extendit. Elytra ferruginea, punctato-striata. Pedes ferruginei; tibiis anticis dentibus 5 obtusis nigris.

15. Bolboceras capitatus, Westw.; obscurè castaneus subnitidus, capite et pronoto minutissimè punctatis: hoc utrinque excavatione maximâ cornubus duobus compositis magnis separatâ, tibiis anticis obtusè 6-dentatis.—Long. corp. lin. $10\frac{1}{2}$. (Tab. III. fig. 20, 21.)

Hab. in Assam, Indiæ orientalis. Muss. *Melly* et *Saunders*.

Species magna et pronoto valdè armato distincta. Caput nigricans obscurum vix punctatum, utrinque ad marginem internum oculorum carinâ tenui (quæ ad clypeum extendit) instructum, lateribusque inter antennas et basin clypei elevatis; inter antennas etiam carina parùm curvata transversa exstat. Prothorax maximus suprà posticè valdè elevatus; lateribus excavatione maximâ profundâ notatis quæ ad angulum anticum extendit, ubi dente infero armata. Pars media pronoti magis punctata, in cornua duo crassa et obtusè dentata divergentia, plùs minùsve elevata et elongata extendit, spatio intermedio inter cornua etiam excavata est, parteque posticâ lævior. Elytra magis castanea, tenuissimè punctato-striata. Femora castanea, fulvo-hirta. Tibiæ et tarsi picei; tibiæ anticæ extùs obtusè 6-dentatæ. Antennarum clava et setæ fulvæ.

Variat mas cornubus intermediis pronoti brevioribus et anticè parùm obliquè porrectis. (Mus. *Westwood.* India; *D. Boys.*)

Fœmina rufo-castanea, mandibulis apice nigris; dextra extùs magis rotundata et ante apicem incisa. Clypeus margine antico recto parùm elevato. Vertex inter oculos carinâ elevatâ transversâ abbreviatâ. Prothorax anticè valdè retusus et ferè lævis, in medio carinâ transversâ paullò curvatâ, utrinque tuberculo elongato curvato carinâque curvatâ ad angulos anticos extensis; cum impressione rotundatâ versus angulos posticos. Aliter mari similis. Mus. *Westwood.* India; *D. Boys.*

Tab. III. fig. 20, mas magnitudine vix auctus; 20 *a*, caput et prothorax a latere visa; fig. 21, fœmina paullò aucta; 21 *a*, caput et prothorax a latere visa.

16. Bolboceras inæqualis, Westw.; rufo-castaneus, antennarum clavâ fulvâ, capite suprà concavo carinâ transversâ in parte posticâ, pronoto anticè valdè retuso suprà quadridentato fossulâque mediâ profundâ, elytris striato-punctatis, tibiis anticis 6-dentatis.—Long. corp. lin. $6\frac{1}{4}$. (Tab. IV. fig. 14.)

Hab. in Indiâ orientali. *Dom. J. B. Hearsey.* In Mus. *Westw.*

Caput nitidum, supra concavum, sub lente punctis minutissimis, carinâ verticem e clypeo separante elevatâ et valdè angulatâ, carinâ etiam transversâ inter partem posticam oculorum instructum; lobi laterales ante oculos rotundati, margine antico reflexo. Antennarum clava et setæ fulvæ. Prothorax glaber, valdè elevatus, parte anticâ valdè excavatâ dentibusque 4 erectis armatus, duobus intermediis approximatis spatioque medio (pone dentes intermedios) excavato*; lateribus etiam impressione ovali versus angulos posticos. Elytra concolora, glabra, striato-punctata; striis gracillimis. Tibiæ anticæ 6-dentatæ.

Tab. IV. fig. 14, mas magnitudine auctus; 14 *a*, caput et prothorax a latere visa.

17. Bolboceras bicarinatus, Westw.; castaneo-fulvus, capite inter oculos et ad basin clypei carinis duabus transversis nigris, pronoto tuberculis duobus parvis parùm elevatis ante medium, tibiis anticis 7-dentatis.—Long. corp. lin. $8\frac{1}{2}$. (Tab. IV. fig. 15.)

* The excavation of the front of the pronotum may perhaps be better described as having its hind margin 6-sinuated, with two elevated horns in the middle.

Hab. in Indiâ orientali. Mus. *Melly.*

Castaneo-fulvus. Caput et pronotum disco lateribusque punctatis; inter oculos carinâ elevatâ transversâ alterâque ad basin clypei quæ ad marginem externum oculorum extendit, nigris. Prothorax punctatus, parte posticâ lævi; utrinque pone oculos impressione parùm profundâ instructus, tuberculisque duobus transversè positis vix elevatis ante medium pronoti lineâque tenui longitudinali ferè ad basin scutelli extensâ. Elytra ut in *B. Lecontei* punctato-striata: striis quinque mediis ad basin elytrorum magis impressis. Tibiæ anticæ 7-dentatæ. Femora subtùs pallidè fulva.

Tab. IV. fig. 15, insectum magnitudine paullò auctum; 15 *a*, caput et prothorax a latere visa.

18. Bolboceras dorsalis, Westw.; rufo-castaneus, capitis vertice et medio pronoti nigris punctatis, capite in medio verticis tuberculis tribus conjunctis instructo, pronoto punctatissimo fere regulari, tibiis anticis 8-dentatis.—Long. corp. lin. 7½. (Tab. IV. fig. 16, caput et prothorax.)

Hab. in Indiâ orientali. Mus. *W. W. Saunders.*

Forsitan fœmina speciei cujusdam haud ritè determinatæ. Caput punctatum, margine tenui elevato ad marginem internum oculorum extenso; vertice in medio tuberculis tribus transversè positis et conjunctis. Pronotum irregulariter punctatum, medio nigrum, lateribus rufo-castaneis: dorso ferè regulari, lineâ impressâ vix distinguendâ e margine antico versus medium extensâ alterisque duabus obliquis anticis cum impressionibus duabus ordinariis versus angulos posticos ferè inconspicuis. Elytra rufo-castanea, tenuissimè punctato-striata. Tibiæ anticæ 8-dentatæ.

19. Bolboceras nigriceps, Westw.; obscurè castaneus punctatus, capite nigricanti carinâ arcuatâ ad basin clypei tuberculisque tribus verticalibus, pronoto lineâ longitudinali impressâ et utrinque cum tuberculo parùm elevato, tibiis anticis 7-dentatis.—Long. corp. lin. 7½. (Tab. IV. fig. 17, caput et prothorax suprà visa; 17 *a*, eadem a latere; 17 *b*, tibia antica.)

Affinis præcedenti et forsitan fœmina speciei diversæ. Caput lineâ tenui elevatâ marginatum, ad basin clypei curvatâ, et ad marginem internum oculorum extensâ; vertice tuberculis tribus conjunctis parùm elevatis et transversè positis instructo. Pronotum lineâ parùm impressâ centrali longitudinali et utrinque tuberculo parvo parùm elevato instructo, disco minutè punctato. Femora subtùs fulva. Tibiæ anticæ 7-dentatæ.

20. Bolboceras transversalis, Westw.; fulvo-castaneus, capite lato carinâ rectâ transversâ elevatâ inter oculos, pronoto lineâ longitudinali anticè dilatatâ impresso.—Long. corp. lin. 4½. (Tab. IV. fig. 18, caput et prothorax.)

Hab. in Indiâ orientali. Mus. *Melly.*

Obscurè fulvo-castaneus. Caput latum irregulariter et valdè punctatum, margine tenui elevato ad marginem internum oculorum extenso, vertice carinâ rectâ transversâ elevatâ instructo. Pronotum minùs punctatum, lineâ mediâ longitudinali impressâ lævi anticè dilatatâ notatum. Elytra striato-punctata; antennarum clava pallidè lutea.

21. Bolboceras Indicus, Hope, MS.; fulvo-rufus, capite anticè tuberculis duobus conicis erectis armato, pronoto lævissimo anticè excavatione semicirculari parùm profundâ notato, calcari pedum anticorum elongato obtuso, tibiis anticis 9-dentatis.—Long. corp. lin. 4. (Tab. IV. fig. 19, caput et prothorax.)

Hab. in Indiâ orientali centrali. In Muss. *Saunders* et *Hope.*

Nitidissimus et, nisi sub lente visus, lævis. Caput tamen magis evidenter punctatum, ante medium tuber-

culis duobus conicis elevatis armatum; lineâque tenui elevatâ marginali ad basin clypei rectâ, et ad latera interna oculorum extensâ. Pronotum anticè impressione parùm profundâ, semicirculari, disco omninò regulari. Elytra punctato-striata. Tibiæ anticæ 9-dentatæ.

Hoc insectum pro fœminâ haberi possit, attamen dentes duo verticales sexum masculinum forsitan indicant. Individuum alterum (masculinum?) etiam possidet *Dom. Saunders* huic magnitudine, colore, formâ et patriâ simillimum; differt vero capitis carinâ tenui transversâ ad basin clypei breviori, tuberculis verticalibus nullis, carinâ autem transversâ inter oculos; pronoto etiam anticè parùm excavato tuberculisque duobus rotundatis vix elevatis armato. (An species diversa?)

22. Bolboceras triangulum, Westw.; rufo-fulvus nitidus parcè punctatus, clypeo carinâ curvatâ (in medio angulatâ), verticeque tuberculis tribus, pronoto anticè retuso: parte retusâ e posticâ lunulâ semicirculari separatâ.—Long. corp. lin. $4\frac{1}{2}$. (Tab. IV. fig. 20.)

Hab. in Indiâ orientali, Mussooree, in stercore bovino. *D. Bacon*, in Mus. *Laferte.*

Rufo-fulvus, punctis magnitudine variis impressus; elytris sub lente punctis paucis minutissimis, serieque ordinariâ striarum punctatarum; scutello punctato. Antennæ fulvæ. Mandibulæ castaneo-nigræ. Clypeus margine antico elevato, in medio angulato, lineâ tenui elevatâ ad verticem ductâ; tuberculis duobus inter basin antennarum alteroque posteriori triangulum formantibus; angulis lateralibus ante oculos obtusis. Pronotum anticè retusum, medio marginis antici parùm angulato; parte retusâ ferè circulari subconcavâ, et e posticâ lunulâ parvâ separatâ; canali tenui mediâ longitudinali e lunulâ versus marginem posticum extensâ. Tibiæ anticæ 8-dentatæ; dentibus apice castaneo-nigris.

Tab. IV. fig. 20, caput et prothorax suprà visa; 20 *a*, eadem a latere.

23. Bolboceras lineatus, Melly, MSS.; fulvus nitidus, capite nigro punctato inter oculos tuberculo apice subbifido armato, pronoto simplici maculâ discoidali nigrâ, elytris convexis suturâ spatiisque intermediis longitudinalibus elevatis nigris, tibiis anticis 8-dentatis.—Long. corp. lin. $3\frac{3}{4}$. (Tab. IV. fig. 21.)

Hab. in insulâ Ceylon. In Muss. *Melly* et *Templeton.*

Species quoad colores insignis. Caput nigrum, punctatum; vertice inter oculos tuberculo parvo conico apice subbifido instructo. Pronotum convexum, integrum, anticè vix retusum, nitidum, punctis minutis distantibus, disco in medio plagâ parvâ nigrâ. Scutellum nigrum. Elytra fulva, valdè gibbosa, singulo suturâ et spatiis tribus intermediis longitudinalibus convexis nitidis nigris, apicibus fulvis; singulo spatio convexo utrinque serie punctorum marginato, spatiisque intermediis depressis serie longitudinali punctorum; margine laterali elytrorum nigro, parùm marginato, serieque punctorum intra marginem lateralem instructo.

Corpus subtùs cum femoribus obscurè fulvis, pilis longis pallidioribus. Tibiæ anticæ extùs 8-dentatæ.

Obs. This and the four following species present a peculiar facies, owing to the longitudinal alternately raised spaces on the elytra, and the narrow curved club of the antennæ; but I have not thought it necessary to form them into a separate subgenus.

24. Bolboceras nigerrimus, Westw.; niger nitidus, capite punctato, vertice cornu brevi erecto armato, prothorace anticè retuso excavatione transversâ ovali; disco sparsim punctato, elytris striato-punctatis: spatiis intermediis convexis.—Long. corp. lin. 4. (Tab. IV. fig. 22.)

Hab. in Indiâ orientali, Landour. *D. Bacon*, in Mus. *Laferte.*

Caput latum punctatum, angulis ante oculos rotundatis; vertice inter oculos tuberculo conico glabro instructo. Oculi septo, nisi in spatio minuto postico, in duas partes divisi. Mandibulæ piceæ; partes reliquæ oris castaneo-rufæ. Antennæ fulvo-rufæ, clavâ oblongâ curvatâ pallidè fuscâ setosâ.

Prothorax niger, nitidus, punctis perpaucis in discum irregulariter dispositis, anticè retusus, parte retusâ brevi transversâ, subovali, et parùm impressâ. Elytra valdè convexa, singulo striis 13 punctorum; spatio inter suturam et striam 1am convexo nec non spatio latiori inter strias 3m et 4m et inter 6m et 7m; punctis striæ 7mæ ad basin elytrorum extensis, 8væ et 9næ sub humero evanescentibus, 10mæ et 11mæ extùs ad humerum conjunctis, 12mæ et 13mæ intus marginem lateralem ad basin elytrorum extensis. Corpus subtùs nigrum, setis griseo-fuscis vestitum; jugulum pallidè luteum. Tibiæ anticæ extùs 8-dentatæ.

Tab. IV. fig. 22, insectum multò auctum; 22 *a*, caput et prothorax a latere visa; 22 *b*, antenna.

25. Bolboceras plagiatus, Westw.; niger nitidus, vertice punctato tuberculoque parvo conico postico, prothorace in medio longitudinaliter impresso sparsim punctato utrinque maculis duabus magnis fulvis rotundatis conjunctis, elytris basi latè fulvis striato-punctatis: spatiis intermediis convexis.—Long. corp. lin. 3. (Tab. IV. fig. 23.)

Hab. in Indiâ orientali, Landour. *D. Bacon*, in Mus. *D. Laferte.*

Caput nigrum, latum, punctatum, angulis ante oculos rotundatis; vertice inter partem posticam oculorum tuberculo parvo conico instructo. Antennæ fulvo-castaneæ, clavâ ut in specie præcedenti. Prothorax niger, nitidissimus, sparsim punctatus, disco in medio longitudinaliter impresso, impressione punctatâ, ad marginem posticum vix extensâ, utrinque maculis duabus magnis rotundatis fulvis conjunctis. Elytra valdè convexa basi latè fulva colore lateraliter magis extenso, striis 13 punctatis notato; spatio inter suturam et striam 1am polito convexo, striâ 2ndâ punctorum vix ad basin extensâ, 3tiâ ad basin, inter 3m et 4m spatio latiori convexo nitido; 5â ad basin haud extensâ, 6â ad basin productâ spatio inter hanc et 4m eodem ac spatium inter 3m et 4m; 7â ad basin, 8vâ ante humerum evanescenti, 9nâ extus humerum at basin elytri non attingenti, 10mâ propiùs ad basin accedente, 11mâ valdè abbreviatâ, 12mâ ad angulum basalem extensâ, versus basin subcurvatâ, 13mâ intramarginali. Tibiæ anticæ 9-denticulatæ.

Tab. IV. fig. 23, insectum multò auctum; 23 *a*, caput et prothorax a latere visa.

26. Bolboceras posticalis, Westw.; niger nitidus, capite tuberculo inter oculos, prothorace integro fulvo guttâ parvâ discoidali nigrâ, nitido sparsim punctato; elytris fulvis plagâ maximâ posticâ communi et suturâ nigris striato-punctatis: spatiis intermediis convexis.—Long. corp. lin. 3. (Tab. IV. fig. 24.)

Hab. in Indiâ orientali. *D. Boys*, in Mus. *Westwood.*

Caput latum, nigrum, nitidum, punctatum; clypeo anticè rotundato, angulisque ante oculos rotundatis, vertice inter oculos tuberculo conico nigro nitido instructo. Mandibulæ et labrum piceæ. Antennæ luteæ. Prothorax nitidus, sparsim (præsertim ad latera) punctatus, anticè vix retusus, dorso haud canaliculatus, fulvus, guttâ parvâ dorsali nigrâ. Scutellum nigrum. Elytra convexa, fulva, suturâ latè nigricanti plagâque maximâ posticâ communi piceo-nigrâ, margineque laterali a medio ad apicem piceo, spatiis inter suturam et striam 1m, 2m et 3m, 4m et 5m latioribus et convexis striis 1, 2, 3, 4, 5 ad basin elytri extensis, striis 2â cum 5â, et 3tiâ cum 4tâ posticè conjunctis, striâ 6tâ in medio tantùm apparente, striâ 7mâ pone humerum evanescente, 8vâ et 9nâ anticè et posticè conjunctis serie brevi punctorum (circiter 6) in spatio intermedio inclusâ, 10mâ valdè abbreviatâ, 11mâ pone humerum evanescenti, versus basin parùm curvatâ intramarginali. Tibiæ anticæ extùs 7-denticulatæ. Corpus subtùs cum femoribus castaneum; tibiis obscurioribus.

Tab. IV. fig. 24, insectum multò auctum; 24 *a*, caput et prothorax a latere visa.

27. Bolboceras lætus, Westw.; niger nitidus, capite cornu brevi inter antennas armato, prothorace rufo-fulvo anticè retuso posticè canali tenui impresso, elytris fulvis, scutelli

lateribus suturâ margine tenui externo plagâque laterali nigris.—Long. corp. lin. 5. (TAB. IV. fig. 25.)

Hab. in Ins. Ceylon. *Capt. Champion.*

Caput nigrum, irregulariter rugoso-punctatum; clypeo rotundato, medio marginis antici et lateribus parùm elevatis; vertice tuberculo conico inter basin antennarum armato. Antennæ castaneæ, clavâ oblongâ curvatâ. Labrum et mandibulæ nigræ. Prothorax nitidus, vix punctatus, fulvus, lunulâ minimâ utrinque supra pedes anticos nigrâ, anticè retusus, parte retusâ tuberculis 4 e parte posticâ separatâ, tuberculis 2 intermediis transversim confluentibus, spatio inter hæc et tubercula lateralia undato; disco lineâ tenuissimâ mediâ longitudinali impresso. Scutellum nigrum, læve, medio fulvum. Elytra fulvo-rufa, margine omni tenui suturâque angustè nigris, plagâque oblongâ ejusdem coloris versus marginem lateralem: singulo striis 13 punctorum, spatiis inter strias ferè æqualibus et convexis, striâ 2dâ, 5tâ, 8vâ et 11mâ anticè et posticè abbreviatis. Pedes nigri, tibiis anticis extùs 9-denticulatis.

TAB. IV. fig. 25, insectum multò auctum; 25 *a*, caput et prothorax a latere visa.

Subgenus EUCANTHUS, Westw.

Corpus minùs depressum quam in præcedentibus; pronoto anticè haud retuso. *Tibiæ* anticæ dentibus duobus apicalibus magnis aliisque minutis externis versus basin armatæ. *Elytra* punctato-striata; singulo striis 5 tantùm inter humeros et suturam, punctis profundis.

28. BOLBOCERAS (EUCANTHUS) MELIBŒUS, Fabr. Ent. Syst. i. p. 20; rufo- vel piceo-niger, clypeo carinâ transversâ plus minusve elevatâ (quasi e tuberculis duobus conjunctis formatâ) verticeque cornu brevissimo truncato (parùm emarginato) instructis, pronoto subdepresso inæquali, canali punctatâ longitudinali in medio (marginem anticum haud attingente) impressionibusque lateralibus curvatis punctatis tuberculoque utrinque instructis, elytris glaberrimis punctato-striatis, mandibulâ dextrâ extùs ante apicem profundè incisâ; sinistrâ integrâ.—Long. corp. lin. 4—5½. (TAB. IV. fig. 26.)

Bolboceras concinnus, Dejean, Cat. Coleopt.

Hab. in Americâ boreali. In Mus. *D. Hope.*

TAB. IV. fig. 26, insectum multò auctum; 26 *a*, caput et prothorax a latere visa; 26 *b*, mandibulæ.

Obs. The figure and description are made from the typical specimen formerly in Lee's Cabinet, described by Fabricius, now in the Cabinet of the Rev. F. W. Hope. Count De Laporte and Dr. Klug appear to have described this species under the name of *B. Lazarus.*

29. BOLBOCERAS LAZARUS, Fabr. Syst. Ent. p. 11; Ent. Syst. i. p. 14; Oliv. Ent. i. Gen. 3. pl. 16. f. 146.

This species was originally described by Fabricius as a native of North America, from the Collection of Mr. Yeats. His description is too concise of itself to allow of identification. "Sc. scutellatus, thorace trituberculato, capitis cornu brevi emarginato. Statura parva *Scar. mobilicornis*, capitis clypeus emarginatus utrinque sinuatus. Thorax fuscus canaliculatus tuberculis tribus, medio transverso. Elytra striata rufa." The figure of the species given by Olivier is also equally insufficient; it however shows the elytra to have but few striæ. His description is, however, more precise, the species being stated to be in the Collection of Mr. Lee. He describes the clypeus as terminated by two "dentelures très-

petites;" and on the crown is a "corne courte, large, obtuse ou échancrée," and the prothorax with four "petites élévations obtuses à la partie antérieure et une ligne longitudinale enfoncée à la partie supérieure." From these characters it appears to me that the species is very closely allied to, if not identical with, *Scar. Melibœus*, Fabr.; indeed, since the above remarks were written, M. Chevrolat of Paris has sent me a specimen labelled "*Lazarus*, Fabr. ♂," which differs only from the typical specimens of *Scar. Melibœus*, Fabr., in being rather larger and apparently rather broader. I can, however, detect no specific distinctions between them.

DESCRIPTION OF THE FIGURES.

Tab. III.

Fig. 15. ***Bolboceras Cyclops***, Fabr.
Fig. 16. ***Bolboceras furcicollis***, De Lap., mas.
Fig. 17. ***Bolboceras furcicollis***, var.
Fig. 18. ***Bolboceras ferrugineus***, De Lap.
Fig. 19. ***Bolboceras Calanus***, Hope, MS.
Fig. 20. ***Bolboceras capitatus***, Westw., mas.
Fig. 21. ***Bolboceras capitatus***, Westw., fœm.

Tab. IV.

Fig. 1. Details of ***Odontæus mobilicornis***.
Fig. 2. Details of ***Bolboceras Æneas***.
Fig. 3. ***Bolboceras grandis***, Hope, MS.
Fig. 4. ***Bolboceras subglobosus***, Westw.
Fig. 5. ***Bolboceras carinicollis***, De Lap.
Fig. 6. ***Bolboceras Calanus***, Hope, MS., fœm.?
Fig. 7. ***Bolboceras Calanus***, Hope, fœm. var.?
Fig. 8. ***Bolboceras lævicollis***, Westw.
Fig. 9. ***Bolboceras punctatissimus***, Westw.
Fig. 10. ***Bolboceras lateralis***, Westw.
Fig. 11. ***Bolboceras nigricans***, Westw.
Fig. 12. ***Bolboceras politus***, Westw.
Fig. 13. ***Bolboceras Coryphæus***, Fabr.
Fig. 14. ***Bolboceras inæqualis***, Westw.
Fig. 15. ***Bolboceras bicarinatus***, Westw.
Fig. 16. ***Bolboceras dorsalis***, Westw.
Fig. 17. ***Bolboceras nigriceps***, Westw.
Fig. 18. ***Bolboceras transversalis***, Westw.
Fig. 19. ***Bolboceras Indicus***, Hope, MS.

Fig. 20. *Bolboceras triangulum*, Westw.
Fig. 21. *Bolboceras lineatus*, Melly, MS.
Fig. 22. *Bolboceras nigerrimus*, Westw.
Fig. 23. *Bolboceras plagiatus*, Westw.
Fig. 24. *Bolboceras posticalis*, Westw.
Fig. 25. *Bolboceras lætus*, Westw.
Fig. 26. *Bolboceras* (*Eucanthus*) *Meliboeus*, Fabr.

V. *Experiments and Observations on the Poison of Animals of the Order* Araneidea.

By JOHN BLACKWALL, *Esq., F.L.S. &c.*

Read December 19, 1848.

MUCH has been written about the deleterious property of the transparent colourless fluid emitted from the minute orifice situated near the extremity of the fangs of spiders on the side next to the mouth, when those instruments are employed to inflict a wound. The numerous accounts which have been published by various authors of the singular effects induced in the human species by the bite of the Tarantula (*Lycosa tarantula apuliæ*, Walck.), and of the still more extraordinary mode of cure, together with the serious and sometimes fatal consequences which have been attributed to the bite of the Malmignatte (*Latrodectus malmignatus*, Walck.), must be regarded as amusing fictions in the natural history of the *Araneidea*; and if the opinion, prevalent among arachnologists of the present day, that insects pierced by the fangs of spiders die almost instantaneously, should be found on examination to be at variance with well-ascertained facts, it must in like manner be deemed fanciful.

For the purpose of testing the validity of this opinion, which I had reason to doubt, and in order to determine with a nearer approximation to accuracy than had previously been done, some of the effects produced under divers circumstances by the poison of spiders, more especially the degree of influence it exercises in destroying the vital functions of animals, in the summer of 1846 I commenced an experimental investigation of the subject, the particulars of which are comprised in the following pages.

To avoid confusion, the experiments have been arranged under four distinct heads, corresponding to the objects upon which they were made; namely, the human species, spiders, insects, and inanimate substances. It may be proper to premise that all the animals were adult individuals in vigorous health, and that the temperature of the atmosphere, in every instance recorded, was ascertained by means of a thermometer graduated according to Fahrenheit's scale, and exposed to the open air in a shady situation having a northern aspect.

1. *Experiments on the Human Species.*

On the 19th of July 1846, a female *Epëira diadema* was induced to bite me on the inner side of the left hand, near the base of the forefinger; it continued to force its fangs deeper into the flesh during a period of many seconds, and at last quitted its hold voluntarily, when a little blood issued from the wounds it had inflicted. Though the spider was in a state of great excitement from previous irritation, yet I did not experience more inconvenience from its bite than from a puncture made near it at the same time with a fine needle; indeed, allowing for a considerable degree of compression in the former case, the effects of both injuries appeared to be very similar. The thermometer, while the experi-

ment was in progress, stood at 76°; the air throughout the day was sultry, and an extensive thunder-storm occurred in the evening.

A highly exasperated female *Epëira diadema* was allowed to seize me on the inner side of the left fore-arm, near the carpus, on the 30th of July 1846. It continued for more than a minute to bury its fangs deeper in the flesh, and on quitting its hold voluntarily a little blood flowed from the wounded part, near which a puncture was made simultaneously with a fine needle. The air was sultry, the temperature at the time being 75°, and distant thunder was heard. No difference was perceptible between the results of this and the preceding experiment.

At 11^h 30^m A.M. on the 22nd of August 1846, the thermometer at the time indicating a temperature of 65°, a powerful and much-irritated female *Epëira quadrata* bit me on the inner side of the left fore-arm, near the carpus. It retained its hold for the space of five minutes, occasionally forcing its fangs deeper into the flesh, and on quitting it voluntarily blood issued freely from the punctures. Due allowance being made for the strong degree of compression employed by this robust spider, the effects of its bite did not differ materially from those of a wound made near it at the same time with a needle of an average size, the intensity and duration of the pain being very similar in both instances.

On several occasions, in the month of August 1846, spiders of various species were induced, under the influence of excited feelings, to seize a piece of clean window-glass with their fangs, when the transparent fluid which escaped from the small aperture near their extremity was deposited upon it. The application of this fluid to the tongue did not produce any sensible effect on that organ; but the result was very different when the poison emitted under like circumstances from the sting of the common Wasp, *Vespa vulgaris*; the Hive-bee, *Apis mellifica*; or the Humble-bee, *Bombus terrestris*, was so applied, a powerfully acrid pungent taste being the immediate consequence. A contrast equally remarkable was evinced when these fluids were transmitted into a recent wound; that secreted by the insects caused inflammation accompanied by acute pain; effects, which if produced at all by that secreted by the spiders, were scarcely appreciable.

The legitimate conclusion deducible from the experiments seems to be, that there is nothing to apprehend from the bite of the most powerful British spiders, even when inflicted at a moment of extreme irritation and in hot sultry weather, the pain occasioned by it being little, if any, more than is due to the laceration and compression the injured part has sustained.

The manner in which spiders are affected when pierced by the fangs of animals of their own order demands attention in the next place.

2. *Experiments on Spiders.*

On the 22nd of July 1846, a male *Tegenaria civilis*, in a violent struggle with a female of the same species, deeply inserted his fangs near the middle of the dorsal region of her abdomen, and retained his hold for several seconds; from the punctures thus made a brown fluid issued copiously, and in a few minutes coagulated. The injured spider appeared to suffer very little from the severe wounds it had received, as it speedily constructed a small web in the phial in which it was confined, and continued for more than a year to

feed freely on the flies introduced to it. The thermometer, at the time the experiment was made, indicated a temperature of 74°.

In a hostile encounter between two female spiders of the species *Segestria senoculata*, on the 29th of July 1846, one of them was pierced by the fangs of her opponent on the under side of the abdomen, near the spinners. A transparent colourless fluid oozed from the wounds for many minutes, and ultimately coagulated; but the spider seemed to experience little inconvenience from the injury, being lively in its motions and preying eagerly upon the insects with which it was supplied. The temperature at the time was 76°, and the atmosphere was highly electrical.

A female *Ciniflo atrox* was bitten by an exasperated female *Lycosa agretyca* near the middle of the cephalo-thorax, on the 29th of July 1846, the temperature by the thermometer being 76°. The *Lycosa* retained its hold for many seconds, and on quitting it voluntarily a transparent colourless fluid flowed from the punctures and coagulated. The wounded spider, apparently regardless of the injury it had received, spun a web with which it long continued to ensnare its victims.

On the same day, the mercury in the thermometer denoting a temperature of 75°, a female *Epëira diadema*, in a violent struggle with a female *Cælotes saxatilis*, pierced her abdomen in the medial line of the dorsal region, about a third of its length from the spinners. The wounded spider did not exhibit any marked symptoms of distress and speedily resumed its accustomed habits.

In an attack made by a female *Ciniflo ferox* upon a female *Lycosa agretyca*, on the 30th of July 1846, the temperature being 74°, the latter was wounded by the fangs of its assailant at the base of the coxa of the left posterior leg, and a transparent fluid, which soon coagulated, issued from the injured part. Nothing occurred afterwards to indicate that the *Lycosa* had suffered from the encounter.

Two female spiders of the species *Epëira diadema* engaged in a severe contest on the 30th of July 1846, the thermometer standing at 73°, when one of them was seized by the fangs of her antagonist near the middle of the right side of the abdomen. A brown fluid flowed from the punctures and soon coagulated, but the spider appeared to be only slightly and very briefly affected by the injury.

A female *Epëira diadema*, in a highly excited state, bit itself near the middle of the femur of the left anterior leg, on the 5th of September 1846. The temperature at the time was 69°, and a transparent fluid flowed copiously from the wounded part; coagulation, however, quickly ensued, after which the spider manifested no unfavourable symptom whatever.

Extensive mechanical injuries commonly prove fatal to spiders, whether received in conflicts with their congeners or otherwise, the extinction of life being more or less rapid in proportion to the vitality of the part lacerated; but no evidence supplied by the foregoing experiments indicates that the fluid emitted from the orifice in the fangs of the *Araneidea* possesses a property destructive to the existence of animals of that order when transmitted into a recent wound; in short, it does not appear to exercise any greater degree of influence upon them than it does upon the human species.

I now proceed to show how insects are affected when pierced by the fangs of spiders.

3. *Experiments on Insects.*

1846. August 7th. A female *Epëira diadema* inflicted a severe wound on the mesonotum of a common Wasp, near the base of the right anterior wing, at 11ʰ A.M., the temperature at the time being 74°. The wasp, though disabled from flying, survived the injury for the space of thirteen hours.

August 7th. At 1ʰ 30ᵐ P.M., the temperature being 72°, a female *Epëira diadema* pierced a Humble-bee, *Bombus terrestris*, with its fangs near the posterior part of the mesosternum. The wound deprived the humble-bee of the power of flight, but did not terminate fatally till 11ʰ P.M. on the 10th.

August 8th. Temperature 68°. A female *Segestria senoculata* seized a Flesh-fly, *Musca vomitoria*, near the middle of the tibia of the right posterior leg, and did not quit its hold for several seconds. A transparent colourless fluid issued from the wounds made by the fangs of the spider, but the fly retained the use of its wings, and did not expire till evening on the 10th.

August 13th. Temperature 64°. At 5ʰ 15ᵐ P.M. a female *Segestria senoculata* inserted its fangs about the middle of the abdomen of a large Green Grasshopper, *Acrida viridissima*, and retained its hold, which it quitted voluntarily, for many seconds. A greenish-yellow fluid flowed copiously from the punctures, yet the insect continued to be lively in its movements, leaping with agility up and down the glass vessel in which it was confined, and ceased not to exist till midnight on the 15th.

August 14th. Temperature 66°. A female *Epëira diadema* pierced a large Green Grasshopper at 4ʰ 43ᵐ P.M., burying one fang at the base of the antenna on the right side, and the other in the right eye. The spider retained its hold for several seconds, and on quitting it a greenish-yellow fluid issued from the former wound and a dark brown fluid from the latter. Notwithstanding the serious injuries the grasshopper had received, no diminution of its activity was apparent, and it did not expire till afternoon on the 16th.

August 29th. Temperature 69°. At 1ʰ 22ᵐ P.M. a Hive-bee had its abdomen extensively lacerated near the middle of the left side by a female *Epëira quadrata*. A large quantity of transparent fluid flowed from the wound, but death did not ensue till 3ʰ 18ᵐ P.M.

September 3rd. Temperature 68°. A common Crane-fly, *Tipula oleracea*, punctured by the fangs of a female *Segestria senoculata*, at 4ʰ 35ᵐ P.M., about a quarter of an inch from the posterior extremity of its abdomen, survived till 8ʰ 7ᵐ P.M.

September 7th. Temperature 69°. At 1ʰ 45ᵐ P.M. a Flesh-fly was bitten by a female *Epëira diadema* on the under side of the abdomen, near its posterior extremity, and a brownish fluid continued to ooze from the wounds till 5ʰ 18ᵐ P.M. on the 8th, when the fly expired.

September 7th. Temperature 68°. A common Crane-fly was seized near the posterior extremity of the abdomen, at 4ʰ 54ᵐ P.M., by a female *Epëira quadrata*. A brownish fluid issued from the punctures made by the fangs of the spider, and the existence of the insect terminated at 6ʰ 9ᵐ P.M. on the 8th.

September 10th. Temperature 64°. Pierced a Flesh-fly through the middle of the left side of the abdomen with a fine needle, at 12ʰ 14ᵐ P.M.; a transparent fluid issued from the wound, which the fly survived till 4ʰ 20ᵐ P.M. on the 11th.

September 10th. Temperature 65°. At 1h 13m P.M. a common Crane-fly was pierced through the left side of the abdomen, near the middle, with a fine needle; the insect expired on the same day, at 5h 29m P.M.

September 10th. Temperature 65°. The point of a strong needle was deeply inserted into the right side of the abdomen of a large Green Grasshopper, near its anterior extremity, at 1h 20m P.M. Though the injury was severe, the life of the insect did not become extinct till 7h 41m P.M. on the 12th.

September 10th. Temperature 66°. The right side of the abdomen of a common Wasp was penetrated near the middle with the point of a fine needle, at 2h 5m P.M.; a transparent fluid oozed from the puncture, and the life of the wasp terminated at 10h 20m P.M.

September 18th. Temperature 60°. A male *Tegenaria civilis* deeply inserted its fangs near the middle of the mesonotum of a House-fly, *Musca domestica*, at 10h 10m A.M., and retained its hold for more than an hour and a half. The victim continued to manifest unequivocal signs of life till 10h 44m A.M., and appeared to sink gradually from mere exhaustion. All the time it was in the grasp of its enemy, with the exception of short intervals, it was perceived to have a slight nodding motion, which was discovered to be caused by the act of deglutition on the part of the spider, a synchronous motion being always observed in the fluid suddenly and copiously propelled into the spider's mouth, and then by degrees reduced in volume in exact proportion to the continuance of the nutation. Whenever the fluid was withdrawn from the mouth a fresh supply was speedily introduced, and after mingling with that extracted from the body of the fly, was conveyed into the stomach of the spider by a repetition of the act of swallowing, thus occasioning the nodding motion with intervals of repose apparent in its prey.

September 18th. Temperature 61°. At 10h 20m A.M. a female *Tegenaria civilis* seized a House-fly with its fangs near the middle of the mesonotum, and did not relax its hold for more than an hour. The struggles of the fly became gradually more feeble, till they ceased altogether at 10h 47m A.M. The nodding motion of the victim, and all the attendant circumstances, were as conspicuous in this instance as in the preceding one.

September 18th. Temperature 64°. A female *Segestria senoculata* penetrated with its fangs the right side of the mesonotum of a House-fly at 1h P.M., but did not deprive it of life till 1h 29m P.M. The spider kept its hold about an hour; and a nodding motion of the fly, regularly accompanied by the act of deglutition in its destroyer, with brief and simultaneous pauses in both, was observed during the entire period.

1847. July 15th. Temperature 71°. At 5h 3m P.M. a brilliant Green Fly, *Musca cæsar*, was pierced by the fangs of a female *Agelena labyrinthica* near the posterior extremity of the abdomen, on the under side. After retaining its hold about ten minutes the spider transferred it to the middle of the mesosternum, perforating the part and rapidly extracting the fluids of its prey, whose existence terminated at 5h 26m P.M. A nutation of the fly was constantly observed to accompany the action of swallowing in its adversary.

July 19th. Temperature 70°. A female *Agelena labyrinthica* struck its fangs into the left side of the mesonotum of a Flesh-fly, at 12h 23m P.M., and eagerly extracted its fluids, the act of deglutition being attended with the usual nodding motion of the victim. After ineffectual efforts to escape the insect became exhausted, and finally expired at 12h 43m P.M.

These experiments do not present any facts which appear to sanction the opinion that insects are deprived of life with much greater celerity when pierced by the fangs of spiders than when lacerated mechanically to an equal extent by other means, regard being had in both cases to the vitality of the part injured, as the speed with which existence terminates mainly depends upon that circumstance. It is true that the catastrophe is greatly accelerated if spiders maintain a protracted hold of their victims, but this result is obviously attributable to the extraction of their fluids, which are transferred by oft-repeated acts of deglutition into the stomachs of their adversaries.

From the entire mass of evidence supplied by the experiments taken in the aggregate, it may be fairly inferred that whatever properties characterize the fluid emitted from the orifice in the fangs of the *Araneidea*, it does not possess that degree of virulence which is commonly ascribed to it, neither is it so destructive to animal life when transmitted into a recent wound as it is generally supposed to be. Were I disposed to speculate upon the manner in which it affects insects on being introduced by the fangs into their vascular system, I might conjecture that it has a tendency to paralyse their organs of voluntary motion, and to induce a determination of their fluids to the part injured; but I refrain from dwelling upon a suggestion, however plausible it may appear to be, which in the present state of our knowledge of the subject can only be regarded as hypothetical.

4. *Experiments on Inanimate Substances.*

In the month of September 1846, litmus paper presented to spiders belonging to several genera when in a state of extreme irritation, having their fangs extended, and the transparent fluid which issues from the fissure near their extremity conspicuously accumulated there, on being seized invariably became red as far as the fluid spread round the punctures made in it, a result clearly proving that this animal secretion, though tasteless, is an acid. Care, however, must be taken, in conducting the experiment, not to suffer any fluid from the mouth to blend with that which proceeds from the fangs, either before or after it has been transferred to the litmus paper, the former, rendering the blue colour of the test more intense, and restoring it after it has been converted to red by the action of acetous acid, being decidedly an alkali; consequently, if both combined in due proportions, they would neutralize each other; but as there is usually a much more copious supply of the alkaline than of the acid fluid, its agency would predominate, and scarcely a trace of red would be discerned on the litmus paper.

Submitted to the same chemical tests, the fluid contained in the stomachs of spiders and that which flows from wounds inflicted on their bodies and limbs were found to be alkaline. Now if the frequency and suddenness with which large quantities of fluid are propelled into the mouths of spiders when occupied in extracting nutriment from their prey be borne in mind, the conclusion that they must be ejected from the stomach through the narrow œsophagus and pharynx seems to be inevitable *, as there is not any other

* The statement of Savigny, that some spiders have three pharyngeal apertures, does not appear to be applicable to several of our larger indigenous species, as I have not been able to detect more than one such aperture in *Ciniflo ferox*, *Cælotes saxatilis*, *Tegenaria civilis*, *Agelena labyrinthica* and *Epëira quadrata*, on the most careful inspection.

source known whence they could be derived; and it has been ascertained that if they are applied to litmus paper, which has or has not been reddened by acetous acid, they always produce upon it effects precisely similar to those caused by the gastric fluid, or rather by the fluid contents of the stomach, when subjected to such tests. I may remark that the yellow colour of turmeric paper is rendered brown by the application of the fluids from the mouth and stomach, and that it is restored again by the agency of the fluid secreted by the poison-glands, changes which afford another proof, in addition to those already advanced, of the respective alkaline and acid properties of these animal products.

The instruments employed by the *Araneidea* to seize and destroy their prey are improperly denominated mandibles; I say improperly, because they actually do not constitute any part of the oral apparatus, as Mr. W. S. MacLeay has plainly asserted *; indeed, many eminent zootomists, judging from their position and from the origin of the nerves distributed to them, entertain the highly probable opinion that they are the analogues of the antennæ of hexapod insects, and in accordance with this view of the subject M. Latreille termed them *chelicera*; but so widely do they differ from antennæ in structure and function, that the propriety of bestowing upon them a distinct appellation which does not imply anything hypothetical will scarcely be questioned: I propose, therefore, to name them *falces*.

Much of the misapprehension that exists among arachnologists relative to the *falces* has been occasioned, in all probability, either by the prevailing belief that spiders are destitute of a labrum, or by mistaken notions as to its precise situation. That they possess the organ in a low state of development is undeniable, as I have distinctly observed it in species belonging to the genera *Lycosa*, *Dolomedes*, *Salticus*, *Thomisus*, *Olios*, *Drassus*, *Clubiona*, *Ciniflo*, *Agelena*, *Tegenaria*, *Cœlotes*, *Theridion*, *Linyphia*, *Epëira*, *Dysdera* and *Segestria* †. It is attached by its base to the superior surface of the palate, but the extremity, which is free and usually round or somewhat pointed, can be slightly elevated, depressed, extended, retracted and moved laterally at will. To apply the term mandibles to organs originating above the labrum, and therefore not situated within the mouth, must evidently be erroneous; and I venture to anticipate, upon anatomical considerations, that future investigations will lead to the conclusion that the mandibles of the *Araneidea* are confluent with the palate.

* Annals and Magazine of Natural History, vol. ii. p. 2, note *.

† Professor Owen has detected a rudimental labrum in spiders of the genus *Mygale*. See his 'Lectures on Comparative Anatomy,' Lecture XIX. Arachnida, p. 257.

VI. *On the Œconomy of a new Species of* Saw-fly. *By* JOHN CURTIS, *Esq., F.L.S. &c.*

Read January 15, 1850.

THE general attention which is now paid to Natural History almost daily brings to light some hidden treasure to interest the public and satisfy the inquiring mind. The subject of this communication appears to be one of these novelties, for a knowledge of which I am indebted to a friend who has lately been admitted a Fellow of the Linnean Society.

The insect alluded to belongs to the family *Tenthredinidæ*, a group of *Hymenoptera* so different in œconomy from the rest of that Order, that some entomologists have been inclined to separate it from the aculeate families. In general habits the Saw-flies resemble the *Lepidoptera* in their second or larva-state, usually feeding on the leaves of plants; but there are many instances of their living on the pith in the stems of shrubs *, in fruit †, and evidence is not wanting to lead to an opinion that some are parasitical ‡, whilst others form galls §.

It is not my intention now to enter farther upon these curious anomalies, but to give the œconomy and descriptions of the species before us, which I propose naming, in honour of its captor, Viscount Goderich,

SELANDRIA ROBINSONI.

On the 19th of June, 1848, Lord Ripon's gardener at Putney, Mr. Joseph Jerwood, sent me, by the request of Lord Goderich, forty or fifty caterpillars the size of those figured, which for two years had devoured the leaves of the Solomon's Seal; eating enormous holes in them, and leaving only portions of the fibres, as exhibited in the drawing (fig. 1). During the present year Lord Goderich forwarded to me the following memoranda:—

"Three years ago (1846), about the month of July, I observed that the *only* plant in our garden of Solomon's Seal (*Convallaria multiflora*, L.) was completely covered and almost entirely devoured by larvæ, which I easily perceived must belong to the family of *Tenthredinidæ*. They had at that time almost consumed the entire membrane of the leaves, and many of them were even feeding on the stalks. In a short time after, they had eaten the plant nearly to the ground, leaving only the stronger branches. They did not appear to touch any of the surrounding flowers or foliage, but upon the Solomon's Seal they were extremely numerous, amounting I should think on one small plant to full one hundred.

"The next year they re-appeared in the same numbers, and then, being much struck by

* Dr. Maclean has discovered a larva in the succulent shoots of rose-trees, which may possibly be the offspring of *Emphytus varipes*, a species I have reared from the stems of dog-roses.

† I have found the larvæ of *Selandria testudinea*? feeding in apples, and of *S. Morio* in plums.

‡ *Dielocerus Ellisii*, Linn. Trans. vol. xix. p. 249.

§ *Nematus intercus* causes the rosy galls on willows.

the circumstance, I sent you some specimens, which I believe were dead before you got them, owing to your absence from home. Last year they again appeared, and I then sent you those from which you have so fortunately been able to obtain the perfect fly.

"I have not, as you know, been much at this place of late years, and therefore it is possible they may have existed here before 1846; but I am sure when I was more at Putney, from 1840 to the end of 1843, there were none of them to be found, although the plant was then in the same place as at present. They have never killed the plant, although they have often eaten up all its leaves and tender fibres. It is now the 8th of June, and none have as yet shown themselves this spring."

By a subsequent letter, however, I find that on the 14th Lord Goderich noticed them, but in smaller numbers than in previous years.

The caterpillar has 22 legs, viz. 6 pectoral, 14 abdominal, and 2 small anal feet: it is of a pale greyish green, shagreened, with very narrow transverse folds, and there is a slight tint of ochre about the fourth segment and towards the tail, with an indistinct greyish line down the back: the head and six horny pectoral legs are deep black and shining: there is a double row of minute black dots down the back, formed of short spiny tubercles, with a row of similar dots down each side, as well as along the spiracles, which are black, and the folds of the thighs are freckled with minuter spines (2, 2): the trunk or fore-part looks dilated when viewed from above; these larvæ were nearly $\frac{3}{4}$ of an inch long on the 28th of June, when many of them had cast their last skins, which were left sticking to the leaves (fig. 3), and they disappeared in succession, burying themselves from 2 to 4 inches deep in the earth, where they formed small oval cocoons like a coating of glue, but often perforated in places (fig. 4).

In the present year I had the satisfaction of breeding a male fly on the 30th of April; on the 3rd of May another hatched, and also two females, and these were succeeded by several more of the latter sex which emerged from their tombs. They were as black as ink, and appear to be allied to *Selandria fuliginosa* of Schrank; but the male antennæ approach those of *Cladius*, and altogether these Saw-flies are different from any I have seen. The entire body is shining black; the male being smaller than the female (fig. 11): the head is transverse, with two lateral *eyes*, and three *ocelli* on the crown, forming a slightly depressed triangle (fig. 5): the mouth (fig. 6) is composed of a semicircular, ciliated *labrum* (*a*), of two bifid *mandibles* (*b*, *b*), of two elongated *maxillæ* (*c*, *c*), towards the extremities of which are attached long, slender, pubescent *palpi*, composed of six joints, the basal one short, the remainder tolerably equal in length (figs. *d*, *d*): the *mentum* is small, producing a nearly orbicular, tripartite, membranous *labium* (fig. *f*); from the superior angles of the chin arise the short *labial palpi*, which are stout, pubescent and 4-jointed, the third and fourth joints the stoutest, the latter slightly notched at the apex (figs. *g*, *g*). *Antennæ* 9-jointed; those of the male (fig. 7) are nearly as long as the body, filiform and densely ciliated internally; the basal joint is short and ovate; second subglobose; third elongated, clavate, the following rather longer; the apical joint slender, incurved and pointed: in the female they are nearly as long, but more slender, and not ciliated, but pilose: the *abdomen* is elongate-ovate and the apex bilobed in the male; stouter and conical in the female, the testaceous *ovipositor* being received into a groove beneath: the ample

wings are entirely black, with the costa and stigma thickened and darker, as well as the nervures, the surface being iridescent; the *superior* (fig. 8) have two marginal and four submarginal cells; the first minute, the second twice as large, the other two very large, the third receiving the transverse nervures which divide the marginal and discoidal cells; the *inferior* have only one discoidal cell (fig. 8*): the *legs* are moderately stout and pubescent; the tibiæ are spurred at the apex, the spur of the anterior pair notched at the apex; tarsi 5-jointed, the first four lobed beneath; the last joint terminated by two bifid testaceous claws and simple pulvilli (fig. 9).

Although the elongated antennæ of this *Selandria* resemble those of *Nematus*, and still more those of *Cladius*, this species is not only distinguished from those genera by the divided marginal cell, but the heavy habit of the females especially shows at once the groups to which it is naturally allied, and these affinities are supported by its trophi, which are intermediate between *Athalia*† and *Tenthredo*‡. I may observe that the number of discoidal cells in the inferior wings varies in the species of *Selandria*, a character hitherto unnoticed, but which may supply admirable distinctions for reducing the genus into sections. 1st, Those with two discoidal cells, the marginal cell receiving one transverse nervure, of which *S. serva*, Fab., is an example (fig. 13). 2ndly, *S. stramineipes*, Klug, in which both transverse nervures are united with the marginal one (fig. 14). 3rdly, Those with one discoidal cell, as shown in *S. Robinsoni* (fig. 8*); and 4thly, Those having no discoidal cell, as in *S. fuliginosa*, Schr. (fig. 15). The variations in the position of the nervures and the magnitude of the cells will also be found very useful in identifying the species; and although occasionally the nervures are not symmetrical, and occasionally the recurrent ones are wanting, such exceptions will not invalidate the divisions I have traced, but will, I trust, lead to a more careful investigation of this fine and interesting family.

EXPLANATION OF THE PLATE.

Tab. V.

[*Obs.* Those figures with a * attached are magnified.]

Fig. 1. A portion of the stem of *Convallaria multiflora*, as eaten by the larvæ of *Selandria Robinsoni*.
Fig. 2, 2. The larvæ feeding in two different skins.
Fig. 3. One of the skins cast off and sticking to a leaf.
Fig. 4. The cocoon, with the end opened by the fly when it hatched.
Fig. 5*. Head of the male viewed above.
Fig. 6*. The trophi or mouth.

Fig. *a**. The *labrum* or upper lip.
Fig. *b*, *b**. The two *mandibles* or jaws.
Fig. *c*, *c**. The two *maxillæ*.

† Curtis's Brit. Ent. fol. & pl. 617. ‡ *Ibid.* fol. & pl. 692.

Fig. *d*, *d**. The two *palpi* or feelers.

Fig. *f**. The *labium* or under lip arising from the *mentum* or chin.

Fig. *g*, *g**. The two *palpi* attached to the *mentum*.

Fig. 7*. *Antennæ*, or horns of the male.

Fig. 8*. Superior wing of *Selandria Robinsoni*.

Fig. 8* Inferior wing of ditto.

Fig. 9*. A fore-leg of ditto.

Fig. 10. Natural dimensions of the male fly.

Fig. 11*. The female, represented flying.

Fig. 12. Natural dimensions of that sex.

Fig. 13*. Inferior wing of *Selandria serva*, Fab.

Fig. 14*. Inferior wing of *Selandria stramineipes*, Klug.

Fig. 15*. Inferior wing of *Selandria fuliginosa*, Schr.

Belitha Villas, Barnsbury Park,
November 1849.

[illegible] del.

G. Jarman S.

VII. *On the Family of* Triuriaceæ. *By* John Miers, *Esq., F.R.S., F.L.S. &c.*

Read April 2 and 16, 1850.

It is now about nine years since I offered to the notice of the Linnean Society the description of *Triuris hyalina*, which was honoured by a place in its Transactions *. Upon that occasion, after giving the details of its structure, I remarked, that as it could not be referred to any known natural order, it might be received as the type of a distinct family, which I suggested as holding a place near *Fluviales*, or *Burmanniaceæ*, but whose positive rank in the system could not be known until we obtained some information relative to the structure of the seed and its embryo †.

The subsequent discovery, by my much lamented friend Mr. Gardner, of a very analogous plant with female flowers only, differing in no respect from *Triuris*, except in having six divisions instead of three in the perianthium, and in a more lateral and less pointed style, supplied an interesting fact; but as its carpels were not in a more advanced state of development, it afforded no insight whatever into the structure of the seed. That indefatigable botanist, whose recent loss we must all greatly deplore, in the paper he presented to the Society on this subject ‡, offered several speculations upon the affinities of his plant and of *Triuris*, tending to show, as I will prove, erroneously, that they were allied to *Smilaceæ*; and upon such unestablished data he drew out § a diagnosis of the family I had previously suggested. In that memoir he stated, that in juxtaposition with his plant he found another of similar size, presenting a single petiolar blade, much resembling the leaf of a *Cissampelos* ‖. Although he failed in tracing any underground connexion between the roots of these two plants, he concluded too hastily that the one appertained to the other, and hence he inferred that his plant was related to *Menispermaceæ* or *Smilaceæ*. He offered at the same time an opinion, that I had overlooked a similar distinct leafy appendage in *Triuris*; but this certainly was not the case, for on quitting the Organ Mountains in 1838, I carefully gathered all the specimens I could find, with the soil and moss attached, keeping them well moistened for two months, until I embarked for England, hoping to witness a further development of the ovaria: at the same time, I examined the moss for any remains of seed or seed-vessel of previous growth: and hence I feel assured that had any such leafy appendage existed in connexion with *Triuris*, it could not have escaped my frequent and searching observation. The stem of *Triuris*, in the living state, is quite hyaline and transparent, appearing composed of simple cellular tissue, without any visible longitudinal vessels, except toward the centre, where it is somewhat more compact. On comparing Mr. Gardner's plant with *Triuris* in the dried state, both exhibit a similar structure, appearing quite translucent externally, with central darker axile lines. The stem of

* Linn. Trans. vol. xix. p. 77.
† *Ibid.* p. 80.
‡ *Ibid.* p. 155.
§ *Ibid.* p. 160.
‖ *Ibid.* p. 156. tab. 15. fig. 4.

the leaf, however, offers a very different appearance; it is far more opake, not darkened in the centre, but altogether traversed by numerous longitudinal vessels, which can be traced distinctly in continuity with the radiating nervures of the leaf-blade: this blade has the same texture, similar nervures with finely reticulated venations, even to the same peculiar excurrent free veins terminating abruptly in the centre of all the areoles, and the midrib is excurrent in a long mucronate point, as in the leaf of a *Cissampelos*. Again, the membranaceous tubes that surround the base of the petiolar support do not exist in the plant allied to *Triuris*; these sheaths consist of a simple cuticle with lacerated margins, without nerves or veins, but marked by several parallel lines, which under a lens are seen to be those peculiar ducts formed of dotted spiral walls so frequently seen in the *Menispermaceæ*, and of which no signs are visible in the accompanying plant, or in *Triuris*. The inference hence is irresistible, that the leaf-bearing stem has no connexion with the singular plant that accompanied it, and that it is only a young seedling of some other plant, probably of a *Cissampelos*. It has been necessary to be thus precise upon a point involving the validity of all Mr. Gardner's views regarding the affinities of *Triuris*.

Under these circumstances, the name of *Peltophyllum* can apply only to the *Menispermaceous* plant, and not to the other, for which a new appellation must now be given. As it differs from *Triuris* only in having six instead of three segments to its perianth, the name of *Hexuris* appears the most appropriate; and in order to retain the name of its discoverer in connexion with it, I propose to call it *H. Gardneri*. Its generic character may hence be reformed as follows:—

HEXURIS, Miers. *Peltophyllum*, Gardn.

CHAR. GEN. *Flores* dioici. *Masc.* ignoti. *Fem. Perianthium* profundè 6-partitum, hyalinum, persistens; laciniis obovatis, præfloratione valvatis, singulâ infra apicem cornu subulato duplò longiore gyrato incluso, demùm patentibus, marginibus reflexis. *Ovaria* indefinitè numerosa, minima, densissimè in gynæcium aggregata, sessilia, gibboso-ovata, 1-locularia, 1-ovulata. *Stylus* subulatus, ad faciem internam sublateralis, apice paulùm incrassatus, obliquè truncatus et stigmatosus. *Fructus* ignotus.

Planta *pusilla, Brasiliensis, diaphana, albescens*; rhizomate *fibroso*; caule *erecto simplici vel subramoso*; foliis *bracteiformibus paucis, basilaribus, ovatis, acutis, adpressis, hyalinis*; floribus *solitariis vel subracemosis*; pedunculis 1-*floris basi bracteatis*.

1. HEXURIS GARDNERI, Miers.

Peltophyllum luteum, Gardn. in Linn. Trans. vol. xix. p. 157. tab. 15.

Planta sub-2-pollicaris, hyalina; caule imo foliolis 2 minimis donato; pedunculis 2–3–4 alternis, flore 3-plò longioribus; bracteis folio æqualibus.

Hab. in arenosis umbrosis humidis prov. Goyaz, Brasiliæ. *Gardn.* No. 3570.

Three years subsequently to the presentation of Mr. Gardner's paper, a memoir by Captain Champion appeared *, describing two plants which he had discovered in Ceylon, one of which was evidently allied to the *Sciaphila* of Blume, and both of very analogous structure to the foregoing genera. These, soon after his arrival in Ceylon, he had shown to

* Calcutta Journ. Nat. Hist. vol. vii. p. 463.

Mr. Gardner, who at first was much struck with their resemblance to *Triuris* and his *Peltophyllum*; but on account of their manifest affinity to *Sciaphila* he renounced that idea, and in some observations which he annexed to Captain Champion's memoir, he suggested their position as being in *Artocarpeæ*, that being the station assigned to *Sciaphila* by Endlicher. Captain Champion, on the contrary, was more inclined to place them in *Urticaceæ*, among the *Moreæ*, because of their aggregated carpels on a common receptacle.

The first plant described by Captain Champion is the *Hyalisma ianthina*; it greatly resembles *Triuris hyalina* in habit, and agrees with it, and with *Hexuris*, in being diœcious. The perianthium is cup-shaped at its base, with the border divided into eight pointed segments of equal size, being valvate in æstivation, with the apical points inflected in a vertical umbilicus. The male flowers have four stamens placed opposite each alternate segment, and almost sessile upon a fleshy prominent disc, as in *Triuris*; but the lobes of the anthers, instead of being distinct, are here confluent, at first four-celled, but afterwards bursting into two valves, by a transverse line across the apex on one of the cross polliniferous dissepiments. The ovaria are numerous and aggregated in the female flowers, but the style, instead of being subterminal and sublateral, as in *Triuris* and *Hexuris*, is here nearly basal upon the ventral face. The whole plant, as in those genera, is covered with prominent vesicles, forming a bullulato-cellular epidermis. The more important consideration of the structure of its seed will be noticed in a subsequent page.

The second plant described by Captain Champion, under the name of *Aphylleia erubescens*, is very similar in general habit and structure to *Hyalisma ianthina*, differing only in the number of the segments of the perianthium, which are six, as in *Sciaphila*, with six stamens opposite to them in the male flowers. The carpels in the female flower do not differ much from those of *Hyalisma*, excepting that the style is shorter and ciliately fringed, not long, simple and pointed. In all the pistilliferous flowers I have seen they are constantly somewhat polygamous, with three or fewer stamens, placed opposite the alternate segment, among the outer row of carpels; but whether they are polliniferous or otherwise, I have not been able to determine. The structure of the seed is exactly that of *Hyalisma*.

In Sir William Hooker's herbarium I found a plant of Mr. Cuming's collection from the Philippine Islands, that bears a great resemblance to *Aphylleia erubescens*: like it, the perianthium is 6-cleft, but the segments are not altogether glabrous, being furnished within at the apex with a tuft of long articulated hairs, and the stigma is radiate with similar cilia. I have noticed that all the flowers here are hermaphrodite, the three stamens being intermixed with the carpels, as in Captain Champion's plant above mentioned. The fruit is utricular, and of similar structure.

In the same herbarium is another plant, found by Purdie in Venezuela; it agrees with the two plants last mentioned in the form of its perianthium, and in having its flowers hermaphrodite, that is to say, with only one or two stamens, placed on the margin of a clustered heap of carpels: here, however, the segments are alternately somewhat narrower, the broader segments only having ciliate margins, but all are furnished at the apex internally with long articulated hairs, and the segments, as well as the bracts and bracteiform leaves, are marked with long red spots, as in the two preceding species.

From these facts we may safely conclude, that neither the *Aphylleia* of Champion, nor Cuming's specimen from the Indian Archipelago, nor Purdie's from Venezuela, differ generically from the *Sciaphila tenella* of Blume, a very similar plant from Java, long before described in the 'Bijdragen' of that celebrated botanist.

Being compelled to impugn the accuracy of the observations of others, it is essential that I should detail minutely those facts which alone can guide us to a knowledge of the true affinities of these singular plants, and I therefore proceed to describe the structure of the seed, as I have found it in *Sciaphila*. Captain Champion, in the memoir above quoted, figures and describes the embryo as a comparatively large body lying across, and near the vertex of the albumen, with a pointed radicle as long as the cotyledonary portion; but the whole seed, he says, "is so minute, and difficult of dissection, that it is hard to say whether the cotyledons are one or two;" the radicle, he adds, "is slightly curved, and pointed towards the hilum; the albumen, which is originally liquid, becomes hard as the seed ripens, and usually causes the testa to burst on the side opposite the raphe." Gardner adds, "The radicle is short, conical, and of a brownish colour; the cotyledons elliptical, compressed, and white;" the embryo lies "on the outside of a thin *fleshy* albumen, or but slightly covered with it, on the side of the seed opposite the raphe, nearly straight, and with the radicle directed towards the hilum," which he states to be on the dorsal face of the seed. The albumen, which according to Gardner is "fleshy," is said by Champion to be somewhat "corneous" in *Hyalisma*, and "rather hard" in *Sciaphila*. It is remarkable that such circumstantial details are not only inconsistent with each other, but decidedly at variance with the structure of the seed, as I have observed it.

My observations upon the seed of *Sciaphila* are to the following effect. The outer coat is a distinct utricle, composed of cellular tissue with intervening merenchyma, the inner face being marked with muriform lines, the outer surface formed of large, prominent, subspherical and somewhat overlying vesicles. This bursts along the whole dorsal side, the apex and part of the ventral face, by a gaping line, displaying an entirely free, erect, obovoid body, connected only by its conical support with the base of the utricle. This body, in the dried state, is marked by several (about eight) prominent, dark-coloured, longitudinal ribs, with intervening hollow spaces, which are pellicular and transparent, the ribs being connected with transverse dark bars, and the membranous intervals marked with spots of a dark crimson colour; in the centre, the opake seed is readily distinguished. This structure is rendered more apparent by making a transverse section of the whole, when the seed appears as if enclosed within a second indehiscent utricle: the ribs all spring from the conical support of the seed, and after running parallel are arched over, and all again are united in a dark tumescent strophiole, which is attached to the apex of the seed. This second envelope appears to partake somewhat of the nature of an arillus, in which the longitudinal ribs convey the nourishing vessels, and from whose common points of union the seed is both supported and suspended. The testa of the included oval seed is of a deep crimson colour, marked by several longitudinal lines, with very numerous transverse hexagonoid areolæ, forming an almost scalariform structure; it is hard, testaceous, and lined within by a fine, transparent, reticulated, adhering membrane; but not the smallest trace of any nervure, or distinct raphe, on the surface of the testa, can be distin-

guished, nor any mark of hilum, as described by Capt. Champion. The inner space is wholly filled by a translucent, hyaline nucleus, of so firm a texture, that the hard testa may be broken, without rupturing it; it is quite free, or perhaps connected by a mere point, at the apex of the testa. This nucleus is covered by a thin transparent integument, which is marked with large and somewhat longitudinally hexagonal reticulations, through the areoles of which are seen a number of included spherules of small size, and on making sections in different directions across this nucleus, it will be found to consist of an aggregation of homogeneous, spheroidal, or rather angular cells, which, by pressure, exude a transparent oil, and a quantity of most minute dark grains of solid matter: the cells appear all of equal size, and this arrangement was found to be constant in upwards of thirty very careful sections in various directions, sometimes in clean longitudinal slices cut parallel with the axis, or transversely, by which the whole internal structure was made distinctly apparent: these again were subjected to the compressorium, and examined under the simple and compound microscope of considerable power, but every effort to detect the slightest indication of a distinct embryo, or even to find one cell darker or larger than the others, has completely failed. The uniformity of these results, obtained from the seeds of the two species of *Sciaphila*, those of *Hyalisma*, and also of another genus yet to be described, warrants the conclusion that the nucleus, in all these cases, is deficient of an embryo. The fact that the seeds thus examined were nearly, if not entirely, ripe, is indicated by the bursting of the utricular covering, and their detachment in many cases from their basal support, both in *Sciaphila* and *Hyalisma*, as well as by the hardness and deep colouring of the testa, and the firmness of the nucleus.

The genus *Sciaphila* may be characterized as follows:—

SCIAPHILA, Blume. *Aphylleia*, Champ.

CHAR. GEN. *Flores* monoici vel polygami. *Perianthium* in utroque sexu simile, 6-partitum, basi cyathiforme; laciniis oblongis, acutis, reflexis, æstivatione valvatis, persistentibus. *Masc. Stamina* 6, in hermaphroditis abortu 3–1, in androphorum carnosum ferè sessilia; *filamenta* brevissima; *antheræ* transversim oblongæ, quadratim 4-loculares, apice rimâ transversali 2-valvatim hiantes. *Fœm. Ovaria* plurima, in gynæcium carnosum subglobosum densè aggregata, obovata, sessilia, 1-locularia; *ovulo* solitario erecto. *Stylus* lateralis ferè basalis, plùs minùsve papilloso-subciliatus. *Stigma* truncatum, papilloso-plumosum, raròò simpliciter obtusum. *Carpidia* plurima, densissimè aggregata, obovata, styli basi persistente notata, monosperma. *Pericarpium* utriculare, subtenue, papilloso-rugosum, suturâ dorsali 2-valvatim hians. *Caryopsis* obovata, brevi-stipitata: *endocarpium* arilliforme, 8–10-costatum, costis basi apiceque confluentibus, transversim cancellatis, interstitiis membranaceis. *Semen* ovatum, basi apiceque endocarpio suffultum et suspensum: *testa* colorata, testacea, striis paucis longitudinalibus, aliisque creberrimis transversis scalariformibus signata, apice saturatiùs colorata; *integumentum externum* pelliculare, reticulatum, testæ adnatum; *integumentum internum* tenuissimum, areolis hexagonoideis magnis oblongis reticulatum, nucleum arctè cingens. *Nucleus* (embryo protoblasteus) indivisus, homogeneus, carnoso-cereus, opalinus, cellulosus; cellulis parvis, subglobosis, materie grumosâ succoque oleoso farctis.

Herbæ *pusillæ, utriusque hemisphæræ indigenæ, hyalinæ*; rhizomate *fibroso*; caule *erecto, simplici vel subramoso*; foliis *paucis, bracteiformibus, alternis, ovatis, acutis, adpressis, venis destitutis, celluloso-rugosis*; floribus *simpliciter spicatis, monoicis, ♂ superioribus, ♀ inferioribus*; pedunculis 1-*floris, basi bracteatis*; bracteâ *folio conformi*.

1. SCIAPHILA TENELLA, Blume, Bijdr. 514; "tenerrima carnosa aphylla, scapo simplicissimo erecto, floribus nutantibus, perigonii laciniis reflexis apice villosiusculis, stigmate sessili punctiformi, baccis pluribus glandulis pellucidis tectis, semine sub-triquetro; testâ subcoriaceâ."

Hab. Java.

Obs. Nothing is known of this plant beyond the above description; it was placed by Endlicher among the doubtful genera at the end of his order *Artocarpeæ*, with the remark, "affinitas planè obscura."

2. SCIAPHILA MACULATA; hyalina, caule simplici, foliis bracteiformibus adpressis lineis interruptis rubris maculatis, perianthii laciniis sublanceolatis reflexis apice intùs barbatis: alternis margine ciliatis, floribus inferioribus staminibus 3 cassis ?, carpellis densissimè congestis, utriculo hiante.

Hab. in insulis Philippinis; *Cuming*, No. 2088.

This plant has a very slender erect stem, and is altogether about 3 inches in height; the flowers are alternate and nodding, upon filiform pedicels, 3 lines in length, each with a bract at base; the size of the cauline leaflets is half a line long: the spike forms two-thirds of the length of the whole plant. The structure of the seed has already been described: the length of each utricle is $\frac{1}{30}$th of an inch; the included caryopsis is $\frac{1}{40}$th long, $\frac{1}{80}$th broad; the testa is $\frac{1}{60}$th long, $\frac{1}{120}$th inch broad: the size of each cell of the nucleus is about $\frac{1}{10}$th of its breadth, or $\frac{1}{120}$th inch in diameter.

3. SCIAPHILA PICTA; hyalina, caule subramoso erecto flexuoso, foliis bracteiformibus maculis longis rubris pictis, perianthii laciniis oblongis acutis patentibus rubro-maculatis apice intùs barbatis: alternis sub-latioribus ciliatis; tubo basique laciniarum lineis punctatis creberrimis violaceis ornatis, floribus hermaphroditis (an semper ?), carpellis plurimis densissimè supra discum carnosum congestis staminibus 2 vel unico munitis.

Hab. in Venezuela, ad fluv. Apure, à cl. *Purdie* lect. Octob. 1845.

A single specimen only of this plant exists in the herbarium of Sir William Hooker, and is about 5 inches in height; it is dichotomous, throwing up from near the base two sub-flexuose erect stems, with short, few-flowered, terminal spikes; the pedicels are scarcely 2 lines long, the flowers are very minute, and drooping.

4. SCIAPHILA ERUBESCENS; hyalina tenerrima, foliis bracteiformibus bracteisque acutis rubro-pictis, floribus punctis rubris maculatis, perianthii laciniis æqualibus oblongis acutis glaberrimis reflexis; superioribus masculis; inferioribus fœmineis interdum hermaphroditis, staminibus 3 cassis ?, utriculo bivalvi.

Aphylleia erubescens, Champ. in Calc. Journ. Nat. Hist. vii. p. 468.

Hab. Ceylon, ad Narawalla, prope Galle, in sylvis umbrosis.

This plant is about the size of *S. picta*, throwing up from the base a second scape, as soon as the first has matured all its seeds. The flowers, which are hyaline, with reddish long spots, become purplish when the fruit is well formed; the ovaries and utricles are sanguineous red, and covered with prominent pellucid areoles; the bracts and leaflets are

half a line long, the pedicels 2 lines, and the flowers ½ to ¾ of a line in diameter. Capt. Champion states that he has occasionally found all the flowers pistilliferous, and that the utricles do not burst until some time after the fruit is fully ripe.

Hyalisma, Champion.

Char. Gen. *Flores* monoici vel dioici. *Perianthium* in utroque sexu simile, 8-partitum; laciniis lanceolatis, æqualibus, patentibus, celluloso-rugosis, basi in urceolum coalitis, æstivatione valvatis, persistentibus. *Masc. Stamina* 4, in androphorum carnosum prominulum ferè sessilia, laciniis alternis opposita; *filamenta* brevissima; *antheræ* quadratim 4-loculares, peltatæ, apice lineâ transversali 2-valvatim hiantes; *pollen* sphæricum, simplex. *Pistilli* rudimentum nullum.—*Fem. Stamina* nulla. *Ovaria* plurima (50 ad 60), densissimè in gynæcium carnosum liberum aggregata, obovata, 1-locularia; *ovulo* unico erecto. *Stylus* ferè basilaris, ovario 3–7-plò longior, subulato-filiformis, celluloso-articulatus, apice subobtuso, stigmate inconspicuo. *Carpidia* plurima, utricularia, obovata, breviter stipitata, structurâ omninò *Sciaphilæ*.

Herba *Ceylanica, pusilla, hyalina*; rhizomate *fibroso*; caule *simplici erecto*; foliis *bracteiformibus, alternis, ovatis, acutis, venis destitutis, celluloso-rugosis*; spicâ *terminali*; floribus *pedicellatis, sæpissimè dioicis, interdùm monoicis, et tunc superioribus masculis, inferioribus femineis*; pedicellis 1-*floris, basi bracteatis.*

1. Hyalisma ianthina, Champion (*loc. cit.* p. 466, cum icone); hyalina, caule erecto striato, foliis paucis bracteiformibus acutis, floribus purpurascentibus, perianthii laciniis patentibus marginibus subreflexis bullulato-rugosis.

Hab. Ceylon, prope Galle, in sylvis humidis.

This plant is from 4 to 8 inches in height; the stem is slender, erect, and often flexuose. Capt. Champion states that the flowers are generally monœcious, but his specimens are all, without exception, distinctly diœcious. The leaves and bracts are a line in length; the capillary pedicels 4 lines long, the male flowers 1½ line, the female 2 lines in diameter; the stamens are fixed upon the margin of a somewhat quadrately conical roundish receptacle, very analogous to that of *Triuris*, from which genus *Hyalisma* differs in the form of its anthers, the cells of which are here confluent. It is very easily distinguished from *Sciaphila*, by the extreme length of the persistent style, and its much longer pedicels.

Among the specimens recently sent from Parà by Mr. Spruce, is one much resembling the foregoing plants. The stem is in like manner simple and erect, the flowers spicate and monœcious; the perianth is however here 4-cleft, with only two stamens in the male flowers: in the female the carpels are very numerous and densely aggregated, with a lateral and basal style, as in *Sciaphila*. The fruit is of the same shape, but is not utricular, as the pericarpial and endocarpial envelopes are glued together with woody matter, and are separated, with some difficulty, from the crimson-coloured testa, which, together with the included nucleus, coincides with that above described of *Sciaphila*. I have proposed for it the name of *Soridium*, from σωρὸς, because of its aggregated carpels.

Soridium, gen. nov.

Char. Gen. *Flores* monoici. *Perianthium* in utroque sexu simile, 4-partitum, basi cyathiforme; laciniis ovatis, acutis, patentibus, celluloso-rugosis, æstivatione valvatis, persistentibus. *Masc. Stamina*

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2, supra discum minimum inclusum ferè sessilia, laciniis alternis opposita; *filamenta* brevissima; *antheræ* transversim elongatæ, compressæ, quadratim 4-loculares, rimâ verticali longitrorsùm 2-valvatim et septicidim hiantes: *pollen* globosum, irregulariter sub-3-valvatim rumpens. *Pistilli* rudimentum nullum.—*Fem. Stamina* nulla. *Ovaria* plurima, in capitulum densè aggregata, obovata, sessilia, 1-locularia; *ovulo* solitario, erecto. *Stylus* lateralis et ferè basilaris, pilis longis clavatis plumosus. *Stigma* obconicum, truncatum, piloso-plumosum. *Carpidia* plurima, baccata, radiatim aggregata, obovata, stylo persistente basilari notata, monosperma. *Pericarpium* siccum, subcoriaceum; *semen* ovale; *testâ* colorata, *nucleoque* omninò *Sciaphilæ*.

Herba *Amazonica in uliginosis umbrosis indigena, hyalina*; rhizomate *substolonifero, fibras radicantes hinc inde emittente*; caule *simplici, erecto*; foliis *paucis, bracteiformibus, alternis, ovatis, acutis, venis destitutis, celluloso-rugosis*; floribus *spicatis, masc. superioribus, fem. inferioribus*; pedunculis 1-*floris, basi bracteatis.*

1. Soridium Spruceanum, Miers.

Planta subhyalina; rhizomatis fibris elongatis, ciliatis, incanis; caule erecto, sulcato; foliis paucis, minimis, adpressis; spicâ simplici terminali; floribus fœmineis circiter 7, infimis; bracteâ lineari, acutâ, pedicello æquilongâ.

Hab. Parà, ad Caripi in sylvis umbrosis.

At first sight this plant bears much the habit of *Dictyostega orobanchoides*. Its rhizoma appears somewhat stoloniferous, and to creep along the ground, throwing out at short intervals bunches of long hairy rooting fibres, each fibre springing out of a small cupuliform node, thus showing its endorhizal structure; the prostrate intervals are of the same thickness as the culmiform portion, and bear similar bracteiform leaflets. The spike occupies one-third of the length of the single erect stem, which is slender, sulcated, somewhat flexuose, and from 8 to 10 inches in height; the leaflets are few, and mostly towards the base; they are linear, pointed, 1½ line long. The bracts are also linear, about the length of the pedicels, 1 line long; the flowers expanded measure 2 lines in diameter; the ovaria are from twenty to thirty in each of the female flowers, of which there are from five to seven at the lower portion of the spike. Although the pericarpial and epicarpial coverings of the seed are here glued together into one coriaceous mass by the deposition of woody matter, yet upon making a longitudinal section, the same nervures, basal support, and apical strophiolar process, that form so conspicuous a feature in the arilliform covering of *Sciaphila*, may here be distinctly traced, and the darker-coloured basal support, and apical strophiole, adhere so firmly to the testa, that they are with difficulty removed from it.

Having thus enumerated the facts connected with the history and structure of these remarkable plants, I will now offer a few remarks upon their affinities. They evidently belong to one common group, and coincide with *Triuris* in their general habit, their hyaline cellular texture, the absence of any green colour throughout their substance, their growth in damp shady places, their underground rhizoma, furnished with numerous long delicate fibrillæ, which probably derive much sustenance from the roots of other plants: they also agree in their simple erect striated stem, composed chiefly of cellular tissue and devoid of woody deposit, in their bracteiform veinless leaves, spicate bracteated inflo-

rescence, unisexual flowers, simple perianthium, similar in both sexes, nearly cleft to its base into regular segments, with a valvate æstivation and a cellular epidermis; the male flowers furnished with few stamens, which are seated opposite the segments upon a fleshy disc, or more or less prominent androphorum; very numerous distinct carpels in the female flowers, having a more or less lateral style, and a single erect ovule, and offering a seed of most peculiar structure. These characters do not conform with any other natural family; for which reason, when *Triuris* only was known, I suggested it should form the type of a new order. In regard to the affinities of this group of plants, it is manifest that they bear no analogy with *Menispermeæ* or *Smilaceæ*, as Mr. Gardner at first inferred; nor can they be held related to *Artocarpeæ*, where that zealous botanist, following the example of Endlicher, referred *Sciaphila* and *Hyalisma*. Their structure, totally different habit, simple style, erect ovule, arilliform envelope, and acotyledonous seed, distinguish them in the most decided manner both from *Artocarpeæ* and *Urticeæ*. In order to arrive at their real position in the natural system, we must first determine in what class to seek their nearest alliance.

The facts before shown lead to the inference, that the seed of the *Triuriaceæ* is not only acotyledonous, but inembryonal, a fact not singular in the history of Phænogamous plants. But does the absence of the usual elements constituting an embryo, viz. cotyledon, radicle, and plumula, imply the want of the ordinary function of the reproductive power of the plant from its seed so constituted? It appears that the presence of such elementary parts is not always a necessary condition to the capacity of vegetable reproduction. According to the views of modern physiologists, the embryo is but a normal condition of a leaf-bud and stem, whose gradual increment is due to certain secretory deposits, regulated by fixed laws of cellular expansion, thus producing a highly complicated or low degree of vascular development in every phænogamous plant, from the smallest herb to the most gigantic tree of the forest. But in those plants destitute of real leaves, and composed of little more than simple cellular tissue, void of green colour, and of the fibres and ducts that enter into the structure of most other vegetable substances, we can hardly expect to meet with a reproductive embryo organized in the form of such a normal bud; and it is only consistent with so simple a structure, to expect a nucleus equally simple in its nature, formed merely of an aggregation of cytoblasts, which, under favourably-exciting influences, are endowed with the faculty of self-development. Indeed, we have no satisfactory evidence of the existence of an embryo, in the ordinary sense of this term, in the seeds of *Burmanniaceæ*, &c., notwithstanding that we know they must be constantly reproduced from their seeds.

Mr. Robert Brown, in his learned memoir upon *Rafflesia*, in the nineteenth volume of the Society's Transactions, has shown that the seeds of that genus, although albuminous, possess an embryo of the most simple and reduced form; but the *Balanophoreæ*, which that most distinguished botanist holds to be quite a distinct and even distant family from the *Rafflesiaceæ*, have been shown by Mr. Griffith to be truly inembryonal; and in his paper on *Balanophora* * he describes the structure of its nucleus, and the contents of its cells, as being precisely similar, even in words that answer in every respect for all that is

* Trans. Linn. Soc. vol. xx. pp. 98, 101 and 102.

seen in *Sciaphila*, *Hyalisma*, and *Soridium*, and the figures he gives of it * quite correspond with the details now offered of the seminal nucleus in these genera. Prof. Lindley has long contended that these two families belong to a distinct class, which he calls *Rhizanths* or *Rhizogens*; but Mr. Griffith, in his able memoir above-quoted, wholly accords with Mr. Brown's views on this subject, and states that these plants, though with inembryonal seeds, or with what he calls a homogeneous-embryo-form structure, may, without violating the rules of classification, be considered as aberrant forms of an imperfectly developed state of exogenous or endogenous organization. Thus, Mr. Brown has always considered the *Rafflesiaceæ* to be allied to the *Aristolochieæ*, and Mr. Griffith contends that the *Balanophoreæ* should be placed near the *Urticeæ*.

The considerations before stated naturally lead to the inquiry, if in such plants no embryo exist, using that term in its ordinary signification, how is their propagation effected by a seed with a simple nucleus of aggregated cells? According to the views of most modern physiologists, the earliest development of an embryo within the ovule is the formation of a germinal vesicle (primordial utricle of Mirbel), generated by the action of the pollen-tube upon the embryonal sac, and the degree of perfection in the organization of the cotyledon, radicle, and plumula, is evidently proportioned to the function requisite to the future elaboration of the leaves, or a more or less complex stem; but in the case of leafless plants, the same amount of development would be useless for so simple an economy of structure. This is even seen in plants of a very high degree of floral development, as in *Cuscuta*, for instance, where the embryo of its seeds is altogether deficient (apparently) of the usual requisites of cotyledons, radicle, and plumule †, as it consists of a simple spiral thread, not germinating in the usual manner from two fixed points, but from which pullulating vesicles are produced, indifferently from any point of its surface, thus proving that the organization of the embryo bears an evident relation to the economy of the future plant. The *Orobancheæ* also present a very small undivided embryo, and the *Monotropeæ* have a minute nucleus, in which neither cotyledon nor radicle is perceptible; and this is included in a reticulated arillus, as in *Burmanniaceæ*. Another instance, still more striking, occurs in *Cacteæ*, where in the leaf-bearing genera the cotyledons are fully developed in the embryo, while in the leafless species the embryo is solid and undivided. In the same manner it is probable that in the *Burmanniaceæ*, *Balanophoreæ*, *Triuriaceæ*, &c., the inembryonal nuclei, consisting of a series of germinating cells or cytoblasts, pullulate at certain points, and thus perform all the requisite purposes of reproducing their very simple forms of structure, in a somewhat analogous way to that in which the ordinary embryo effects the more complex organization of vascular fibres and elaborate tissues in the higher orders of Phænogamous plants.

If we admit the existence of an organ, thus endowed with the function, but wanting the usual structure of the embryo, it should hold some adequate designation, and for this the term *Protoblastus* does not seem inappropriate, as it effects the same purpose as the gemmule or plumula ‡. The word used by Mr. Griffith for this organ, "homogeneous embryo," would require that the ordinary embryo, in contradistinction, be called hetero-

* Trans. Linn. Soc. vol. xx. pl. 8. fig. 9–14.

† Lindley, Introd. to Bot. p. 217.

‡ In a similar sense, Richard has applied the term *blastus* to the plumula of the seed in *Gramineæ*.

geneous, which would not accord with its nature; but if these denote only different conditions of the embryonary form, the one may be considered as a *protoblastous*, the other as a *cotyledonous* embryo. On surveying other peculiar embryonal forms, some will be better understood by this view of the subject; for instance, we may conceive that the protoblastus, instead of forming one compact mass of spherules, as in *Balanophoreæ*, *Triuriaceæ*, &c., may be somewhat less aggregated, so as to assume the shape of elongated bundles of cells, such as have been termed paraphysiform: such a form is actually met with in *Ceratophyllum*, where the exterior series of unequal size have been assumed to be an unusual number of cotyledons, and the very numerous inner series have been held to be a highly developed plumule, while the common point of their union is considered as the radicle. The development of this embryo has been well analysed by Schleiden, in his memoir on *Ceratophyllum* *. Professor Lindley remarks †, that "in this instance, as in *Nelumbiaceæ*, the highly developed plumule may be a compensation for the want of albumen, enabling the embryo to germinate without assistance, as soon as it is exposed to the fitting conditions." The leaves of *Ceratophyllum* appear destitute of all nervures, consist of confervoid parallel cells, and dichotomously divide themselves into simply articulated hair-like segments, thus denoting a lower order of development than has been assigned to it. Independently of this cellular texture, we must bear in mind that this genus possesses monœcious flowers, with a simple perianth, having a valvate æstivation, almost sessile stamens, an unilocular carpel with a solitary ovule; and if, in addition to these characters, we regard the construction of its embryo, in the view above contemplated, its position in the system would rank near *Fluviales*, as was long ago suggested by Bernard and Antoine de Jussieu, followed by Jaume St. Hilaire and Agardh, and therefore, as will be seen, not far from *Triuriaceæ*. Conterminous with the *Fluviales* we find another family, the *Aroideæ*, which offers many circumstances bearing upon this subject. Blume describes *Amorphophallus* ‡ as possessing an exalbuminous simple nucleus, homogeneous in texture, with one of its extremities pullulating at one, two, or three points, and throwing out fleshy lobes, which overlap each other. The same botanist records, that in *Aglaonema* the seed has a solid nucleus, which, in germination, throws out several squamulæ at one end §; and Schott states that the nucleus of *Cryptocoryne* emits several gemmulæ in a similar manner ||. This fact has been confirmed and illustrated in an admirable manner by Mr. Griffith, in a very interesting memoir upon *Ambrosinia* (*Cryptocoryne*) *ciliata* ¶, where he has shown, that at an early period the ovule presents an embryo, which then appears to be quite homogeneous, and "entirely cellular," and that its development is first marked by the production, upon a

* Linnæa, vol. ii. p. 512.

† Vegetable Kingdom, p. 263.

‡ In Rumphia, i. 138: "in quo ad extremitatem inferiorem umbilicum spectantem una rarius 2 vel 3 minutæ gemmulæ germinantes observantur; gemmulæ ejusmodi constant squamulis aliquot carnosis sibi oppositis et sese amplectentibus." (Kunth. Enum. iii. 32.)

§ "Embryo semini conformis, exalbuminosus, solidus, ad extremitatem radicularem squamulis aliquot munitus." —Rumph. i. 130. (In Endl. Gen. Pl. Suppl. p. 1370.)

|| "Embryo cotyledonibus (protophyllis?) plurimis."—Schott, Meletem. Bot. (In Kunth. Enum. iii. 12; et Trans. Linn. Soc. vol. xx. p. 266.)

¶ Trans. Linn. Soc. vol. xx. p. 263.

small area of its surface, of several minute oblong cellular bodies, which soon enlarge, others in great numbers being successively formed in their centre. These rudimentary processes soon become more and more elongated, their growth being very rapid, until they acquire five or six times the length of the original globular nucleus, from which, when fully developed, they finally detach themselves, the nucleus remaining enveloped in the swollen integuments. This new production thus assumes the form of a large plumula, still more highly developed than that of *Ceratophyllum*, and separates in the manner above described, as the germ of a future plant, consisting of an immense number of subulate thread-like processes, at least an inch long, which are furnished with vessels, but their chief bulk is cellular, the cells containing a number of green globules. Mr. Griffith remarks, that the cells of the nucleus, as well as of the processes, in an early stage of their development, abound in active molecules, possessed of an exceedingly rapid oscillatory motion; and it is obvious, from the universal presence of these corpuscles during the formation of tissue, that they play an important part in this most obscure process. Mr. Griffith considered the nucleus to be the cotyledon, the processes as forming a plumula, and the neck, which united them at base and which is seated upon the globular cotyledon, to be the radicle; but these parts do not seem to bear any analogy to such elementary portions of the ordinary embryo of phænogamous plants, as is evinced by the quite unusual position of what is here considered a radicle, between the cotyledon and plumula, and by the fact of the detachment of such cotyledon, which has always been held to be necessary to the completion of the germinating functions of the radicle and plumula. Mr. Griffith endeavoured to explain these contradictions by ingenious reasonings, which, however, are far from being satisfactory, as he was forced to acknowledge that this case forms a remarkable exception to the general law of the absolute necessity of a cotyledon in a distinct embryo, and that it is only to be accounted for on the plea that the presence of such a highly developed plumula obviates that necessity. These anomalies, however, appear to me more satisfactorily explained by considering the original nucleus in the light of a simple protoblast, from which a certain number of its cells, animated by the oscillatory motion of the active molecules, as described by Mr. Griffith, pullulate and attain a rapid increment, by the production of a number of thread-like cellular processes (or protophylla) united at their base by the common centre of the original germinating cells (or epiblast). The plumula of Griffith may thus be considered simply as an aggregated bundle of protophyls, destined to form the germs of future leaves; and his radicle may be viewed merely as an epiblast, which, however, performs all the functions of a radicle, by subsequently generating from its former point of attachment other cells to constitute future rooting fibres; and his cotyledon remains only the original protoblast, which having thus performed its function of elaborating a gemmiferous prototype, becomes detached from its offspring. Under this point of view the embryo of *Cryptocoryne* may be considered as protoblastous, and not as cotyledonous, and the anomalies above shown vanish without calling in aid forced exceptions to the ordinary laws of development.

The *Pistieæ*, considered as a suborder of the *Aroideæ*, present some circumstances analogous to the structure of *Sciaphila*. On examining the seed of *Pistia obcordata*, I find that what has been described as its testa is in fact an arillus, which in some degree may

be compared with the arilliform covering above described in the genus just mentioned. The embryo of *Pistia* is cylindrical, nearly half the length of the albumen, in the summit and in a longitudinal cavity of which it is placed, with its apex quite bare, the whole being enveloped by a thin pellicular integument, and this again by a thin and somewhat coriaceous reddish testa, marked much after the manner of that of *Soridium*. This testa is fixed upon a long, thickened, stipitate support, and is crowned at its apex by a dark pulvinate process, suspended by a cylindrical plug or strophiole, the point of which is seen in the umbilical apex of the seed. The external covering is a thick, wrinkled, fungous or pithy substance, lined inside and outside by a thin adhering membrane, and enclosing the stipes, the testa and the strophiole, and it can be considered in no other light than an arillus, and as analogous to the peculiar covering of the testa seen in *Sciaphila*. In the *Zingiberaceæ* the seed is also covered by an arillus somewhat similar to that of *Pistia*, while in *Ravenala*, by its numerous ribs, it approaches yet nearer to the seminal envelope of *Sciaphila*; here, however, as well as in *Pistieæ*, the albumen is of peculiar structure, being farinaceous when dry but becoming distinctly cellular when moistened, and the cells are separable from each other without bursting; they are then translucent, and bear altogether a very different aspect from those seen in the nucleus of *Sciaphila*, in which they are more opake, as if filled with dark grumous matter. The facts here brought together are interesting, as presenting some analogies bearing upon the question, and they serve to show that we have yet much to learn concerning the nature of the more simple forms of embryonal structure, and of the functions of reproduction.

In respect to the position of the *Triuriaceæ* in the system, if we follow the rules of classification founded upon the three great divisions of Acotyledonous, Monocotyledonous, and Dicotyledonous plants, a plan now quite untenable, they must of course range in the same group as the *Balanophoreæ*, although they hold but little relationship with them. But if we regard the condition of the embryo, not as a basis, but merely as a frequent indication of the three great divisions, founded on the structure and development of vegetable fibre, viz. Acrogens, Endogens and Exogens, and if we accord with the views of Mr. Brown and Mr. Griffith, in considering what the latter calls the homogeneous-embryo-form state of the seed merely as an imperfect condition of development, common alike to all these groups, then the *Triuriaceæ* must take their place among the Endogens.

Here, the family that at first sight appears most approximate is the *Alismaceæ*, with which the *Triuriaceæ* agree, in their simple stem, sometimes spicate unisexual flowers, and their numerous carpels; but *Alismaceæ* differ in having leaves with parallel nerves, in their floral envelope being distinctly biserial, the outer calycine, the inner petaloid, and both with imbricated æstivation; they are also dissimilar in their bilocular anthers, with parallel cells, dorsally affixed to long filaments; ovules often two in each carpel, one being superimposed; carpidia opening by their ventral suture, and seeds with large hippocrepiform embryo.

With *Fluviales*, *Triuriaceæ* accord in their soft cellular structure, their monœcious flowers, simple perianthium with valvate æstivation, often 4-locular anthers, several distinct ovaria, with a single erect ovule in *Caulinia* and *Najas*, baccate fruit, with a pericarpial utricle bursting on one side in *Althenia*, *Zostera*, *Najas* and *Cymodocea*; but

the plants of this family differ wholly from the *Triuriaceæ*, in having distinct, entire, large leaves, with long amplexicaul petioles, and intrapetiolar vaginant stipules, in their female flowers arising from the superior axils, in the frequent absence of any perianthium, ovules often suspended from the ventral suture, and very delicate membranaceous testa. Their exalbuminous macropodous embryo may be considered as an approximation to the structure of the nucleus of *Sciaphila*.

With the *Juncagineæ* they agree in their inconspicuous spicate flowers, numerous carpels, with a solitary erect ovule and exalbuminous seeds; but these again differ in their large leaves, with parallel nervures, 2-serial floral envelope, extrorse stamens upon long filaments, and sometimes two ovules in each carpel. The *Juncagineæ*, however, have been considered by some as a suborder of the *Alismaceæ*, by others to be more nearly allied to *Fluviales* and *Aroideæ*, on account of their spicate flowers: indeed, though placed at so great a distance in the system by Endlicher, they are really so closely allied, that the genera *Ruppia* and *Potamogeton* are placed by some botanists in *Fluviales* and by others in *Juncagineæ*.

If we agree in placing these four families in closer juxtaposition in the system*, the *Triuriaceæ* will find a place near them; but, upon the whole, the greatest amount of approximative characters will be seen to lean towards the *Fluviales*, especially through *Potamogeton* (which genus is arranged by Mr. Brown among the *Alismaceæ*), and which possesses a simple perianth of four segments in a single series, with valvate æstivation, and four stamens opposite to them, globose simple pollen and uniovular carpels; and although it bears hermaphrodite flowers, it must be remembered that *Sciaphila* is sometimes bisexual. *Najas* and *Caulinia*, as before observed, present also carpels with a solitary erect ovule.

It now only remains to define the characters of this small order.

TRIURIACEÆ, Miers (1841). *Triuraceæ*, Gardn. (1843). *Triuridaceæ*, Lindl. (1846).

Herbæ parvulæ, subhyalinæ; *rhizomate* fibroso, interdùm substolonifero; *caule* subsimplici, texturâ cellulosâ, vasis deferentibus in axi centralibus; *foliis* alternis, bracteiformibus, sessilibus, nervis destitutis. *Flores* monoici, vel dioici, rariùs polygami, spicati; *pedicellis* alternis, 1-floris, basi bracteatis. *Perianthium* in utroque sexu simile, 3–4–6–8-partitum, hyalinum, texturâ celluloso-bullatâ, vel papilloso-rugosâ; laciniis ovatis, acutis, basi in tubum brevissimum coalitis, apice interdùm processu elongato donatis, æstivatione valvatis. *Stamina* numero varia, pauca, in fundo perianthii ferè sessilia, supra androphorum sæpissimè magnum carnosum inserta; *antheræ* 4-loculares, 2-valves, rariùs in lobos 2 sejunctæ. *Ovaria* plurima, in gynæcium toro adnatum densissimè aggregata, 1-locularia; *ovulo* unico, e basi erecto. *Stylus* excentricus, introrsùm lateralis, sæpissimè ferè basilaris, glaber aut plumoso-fimbriatus. *Stigma* obsoletum, vel truncato-clavatum. *Carpidia* plurima, baccata, radiatim excentrica, obovata, stylo persistente ferè basilari notata, coriacea et indehiscentia, vel interdùm utricularia dorso valvatim dehiscentia; *caryopside* obovatâ, telâ arillæformi donatâ: *testâ*

* This we find adopted in the 'Prodromus Floræ Novæ Hollandiæ' of Mr. Robert Brown, where the *Aroideæ*, *Fluviales*, *Alismaceæ*, and *Juncagineæ* are placed in contiguity, with the intervention of *Pandanus* alone, of which it is worthy of remark that it also offers the peculiarity of an entire and simple embryo: and nearly the same arrangement occurs in the system of De Jussieu.

ovatâ, durâ, testaceâ, coloratâ, transversim scalariformi-striatâ. *Nucleus* (embryo protoblasteus) opalinus, integumento areolis elongatis reticulato inclusus, texturâ mollis, cellulosus; cellulis materie oleosâ grumosâ farctis.

Triuriaceæ in locis humidis umbrosis sylvarum intertropicarum totius orbis epigeæ.

The family may be thus divided :—

§ 1. TRIURIEÆ. Perianthii laciniæ appendice lineari, æstivatione spiraliter tortâ et inclusâ, demùm exsertâ, munitæ. Stylus cum ovario gibboso lateraliter continuus. Antherarum lobi disjuncti, singuli 2-locellati.

Perianthii laciniæ 3. Stamina 3. . . 1. *Triuris.*
Perianthii laciniæ 6. Stamina ignota . 2. *Hexuris.*

§ 2. SCIAPHILEÆ. Perianthii laciniæ ecaudatæ. Stylus ferè basilaris. Antherarum lobi confluentes, et inde 4-locellati, rimâ transversali v. verticali 2-valvatim hiantes.

Perianthii laciniæ 4. Stamina 2. . . 3. *Soridium.*
Perianthii laciniæ 6. Stamina 6. . . 4. *Sciaphila.*
Perianthii laciniæ 8. Stamina 4. . . 5. *Hyalisma.*

EXPLANATION OF THE PLATES.

TAB. VI.

Fig. 1. A plant of *Sciaphila erubescens*:—of the natural size.
Fig. 2. A single male flower.
Fig. 3. The same:—magnified.
Fig. 4. A section of the same, showing three of its stamens placed opposite the segments, upon the central fleshy androphore.
Fig. 5. An anther before dehiscence:—more highly magnified.
Fig. 6. The same, burst open; showing its transverse mode of dehiscence, and the cruciform septa which form the divisions of its four cells.
Fig. 7. A female flower of the same plant, after expansion:—magnified.
Fig. 8. A single pistil, showing its lateral and nearly basal style.
Fig. 9. A fruit:—of the natural size.
Fig. 10. The same, showing its persistent style:—magnified.
Fig. 11. The same, showing the mode in which the pericarp opens and displays its single erect seed.
Fig. 13. A plant of *Sciaphila picta*:—of the natural size.
Fig. 14. A single male flower, in bud:—much magnified.
Fig. 15. The same, expanded.
Fig. 16. A female flower of the same, expanded:—equally magnified.
Fig. 17. An anther, before and after dehiscence.
Fig. 18. A single pistillum, showing its lateral style.
Fig. 19. A plant of *Sciaphila maculata*:—of the natural size.

Fig. 20. A single hermaphrodite flower.
Fig. 21. The same, in bud, and inverted upon its slender pedicel, with its corresponding bract:—magnified.
Fig. 22. The same, reversed, in order to show the position of its three stamens among its numerous pistilla.
Fig. 23. An anther, expanded.
Fig. 24. The style.
Fig. 25. A single flower of the same plant, after the ripening of its fruit:—of the natural size.
Fig. 26. A single fruit:—natural size.
Fig. 27. The same, exhibiting its persistent lateral style:—magnified.
Fig. 28. The same, with the pericarp burst open, exhibiting its single erect seed inclosed in its peculiar endocarpial covering.
Fig. 29. The pericarp, after bursting, with the seed removed.
Fig. 30. The endocarpial covering of the seed, as seen from above, showing its eight prominent ribs.
Fig. 31. A side view of the same, showing the cancellated structure of the endocarp and the markings of its areolæ.
Fig. 32. The same, with half of the endocarpial covering removed, in order to show the mode of attachment of the summit and base of the seed to the ribs of the endocarp.
Fig. 33. A transverse section of the seed and endocarpial covering.
Fig. 34. The seed removed, showing the markings of its testa.
Fig. 35. The nucleus, as seen after the removal of the testa, inclosed in its reticulated integuments.
Fig. 36. A transverse section of the same, showing the granular or cellular structure of the hyaline nucleus.

Tab. VII.

Fig. 1. A male plant of *Hyalisma ianthina*.
Fig. 2. A female plant of the same:—both of the natural size.
Fig. 3. A single male flower with its pedicel and bract:—of the natural size.
Fig. 4. A bud of the same, seen from above, in order to show the mode of æstivation of its eight segments.
Fig. 5. The same, expanded; showing the position of its four stamens upon its fleshy androphore:—much magnified.
Fig. 6. An anther, before and after dehiscence.
Fig. 7. A female flower, expanded:—equally magnified.
Fig. 8. A single pistil, with its elongated basal style:—more highly magnified.
Fig. 10. A plant of *Soridium Spruceanum*:—of the natural size.
Fig. 11. One of its male flowers expanded:—much magnified.
Fig. 12. A side view of one of its stamens:—more highly magnified.
Fig. 13. The same, seen edgeways.
Fig. 14. A section of the same, showing its two cells.
Fig. 15. The same, seen sideways, in order to show its mode of dehiscence.
Fig. 16. A transverse section of the same.
Fig. 17. Grains of pollen, still more highly magnified.
Fig. 18. A female flower supported on its pedicel and bract:—magnified.
Fig. 19. A pistil:—of the natural size.
Fig. 20. The same:—much magnified.

Fig. 21. A longitudinal section of a pistillum, with one half removed, in order to show its single erect ovule.

Fig. 22. A fruit:—of the natural size.

Fig. 23. The same, with its persistent basal style:—much magnified.

Fig. 24. A longitudinal section of the same, exhibiting its single seed enclosed in its fleshy pericarp.

Fig. 25. The seed removed, showing the particular reticulated surface of the testa.

Fig. 26. The same, after the removal of the testa, exhibiting the reticulated texture of the nuclear integuments.

Fig. 27. A transverse section of the same, showing the granular texture of the nucleus.

Fig. 28. A longitudinal section of the entire fruit, exhibiting the structure of the whole.

Fig. 29. A section of the fruit of *Pistia obcordata*, showing its single seed, enveloped by its pithy arillus, its apical strophiolar attachment, its testa upon a basal support, and its embryo placed in the summit of its albumen.

Fig. 30. The embryo of the same.

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VIII. *The Anatomy and Development of certain* Chalcididæ *and* Ichneumonidæ, *compared with their special Œconomy and Instincts; with Descriptions of a new Genus and Species of Bee-Parasites.* *By* George Newport, *Esq., F.R.S., F.L.S. &c.*

Read March 20, 1849.

Preliminary observations.

The parasitic *Hymenoptera* include, in their larva state, some of the most imperfectly organized conditions of life to be found in the whole of the *Articulata*. They leave the ovum delicate, apodal, almost motionless, and entirely incapable of locomotion, and are injured and perish by slight accident, as an abrasion of surface allows the fluids of their bodies to escape quickly and fatally by the wound; and yet these very beings, having passed unhurt through this scarcely other than fœtal condition, acquire a perfection of organization, a degree of activity and power, and an acuteness of instinct, fully equal, and perhaps superior to the organic and the functional endowments of other tribes of insects. One section of them,—some of which I shall make the subjects of this paper,—are nourished entirely by suction, and subsist on the fluids of other insects; and either attached singly to the external surface of the bodies of their victims, or, located internally, between the tissues, they drink up the life-blood prepared for another, without entirely destroying the means of its production. Other species are gregarious and reside in the same cell with their victim; and while that subsists on vegetable food,—pollen mixed with honey and stored up for it by its parent,—it is attacked on all sides by its insidious enemies, succumbs, and dies as they become nourished. Yet the general form of body, and of the digestive organs, at the earlier periods of growth, is almost precisely the same in most of these descriptions of parasite, and the special development of each is regulated by the same laws. They cast their skin at succeeding stages of growth as certainly as do the larvæ of *Lepidoptera*; but the thrown-off covering is of such extreme tenuity, and is so gradually and almost imperceptibly removed, without interfering with the form or the enlargement of the body, that, hitherto, the deciduation of the tegument of the apodal larvæ of *Hymenoptera* has always escaped the observation of naturalists. I have, however, witnessed its repeated occurrence in the genus *Paniscus*, as I shall show in this paper; so that these species do not constitute, as was supposed, an exception in this respect to one general law. Much as they resemble each other in external appearance, they do so still more in the structure of their organs of nutrition. The digestive apparatus in the whole of them is at first but a simple, capacious sac or bag, rounded and closed at its larger extremity, with an imperforated intestine proceeding from it, without an anal outlet. It has this form in most of these insects during the earlier periods of the larva state, when the organizing

powers of the system are most energetic, and when nearly the whole of the food is appropriated to the enlargement of the body. Very little undigested substance then remains, after the assimilation of the nourishment imbibed, and consequently no excretory outlet to the organ is required. But when the assimilation of food begins to be arrested, and the rapidity of growth is diminished, as is the case when the larva is approaching its maturity,—changes which seem to lead to the inference, that the forces of combination in the primary organisms of the body become less and less energetic in proportion to the degree of stimulus to which they are submitted,—the digestive apparatus then assumes a new form: it is narrowed and elongated, and being connected with a column of granulated cell-masses, which, derived originally from the yolk, are continuous with those that constitute the walls of the digestive cavity at one end, and at the other with the tegument, the cæcal extremity of the sac becomes perforated, and the cells separating in the axis of the column form a tube, that is quickly lined with epithelial membrane, to allow the passage of the refuse of digestion, the tegument having previously separated also at a given point, by which an excretory or anal outlet to the canal is completed. The material first removed is composed chiefly of disintegrated epithelial cells, which line the digestive cavity, and are thrown off as they become aged and worn-out, during the elaboration of nutrient fluid, like the cells which form the cast layers of tegument. This change of structure does not take place in any of the parasitic larvæ, so far as I am aware, until the individual is replete with nourishment, and ceases to feed, preparatory to more extensive alterations of form. When this marked period of its existence has arrived, it is first necessary that the unassimilated portions of food, together with the worn-out materials of the body, should be removed, and this necessitates the change from a closed receptacle to a canal. But further reason for this late completion of the organ, as well in those larvæ which are confined to a given space with their food, and in those still more confined between the tissues of other insects, at once suggests itself. In the one case the food stored up must remain pure and uncontaminated, for the support of the larva preyed upon; in the other, the fluids of the victim must not be changed from nutrient to noxious aliment by the engenderment of disease within it, through contact with effete matter from the body of the parasite, and thus destroy what otherwise it would nourish. But the primary object, the healthy maturity of the larva, being attained, the development of the canal is then completed.

PART I. CHALCIDIDÆ.

The two species I am about to describe are parasites in the nests of the wild-bee, *Anthophora retusa*. They seem to differ in their particular economy as in generic character.

The first species is generically distinct, so far as I am able to ascertain, from any hitherto described genus; the other is a species of *Monodontomerus*, which may prove to be identical with a known species, but of which there is some doubt; so that the name which I propose for it must be regarded as provisional.

Fam. CHALCIDIDÆ.

Gen. ANTHOPHORABIA, Newp.

CHAR. GEN.* *Fem.* *Caput* thorace latius. *Antennæ* 6-articulatæ (?), pilosæ; articulis 2do 3tio 4to 5toque subæqualibus, 6to clavam elongato-ovalem efformante. *Thorax abdomen*que longitudine æquales. *Alæ* venâ medianâ bifidâ. *Tarsi* 5-articulati.

Mas. *Antennæ* 4-articulatæ; articulo basali arcuato, magnoperè dilatato, infernè excavato; 2do cylindrico, 3tio magno globoso, 4to elongato-ovali. *Oculi* stemmatosi. *Alæ* abbreviatæ.

As the females of this species are the most numerous, and are most likely to be met with, I have regarded this sex as affording good generic characters, although those of the male are the most extraordinary. The name I propose for the species is

ANTHOPHORABIA RETUSA; *Fem.* (TAB. VIII. fig. 2.) Æneo-viridis, capite magno, oculis compositis nigris, abdomine nitido ovali, alis magnis rotundatis, pedibus flavescentibus. *Mas.* (fig. 1.) Flavus vel saturatè ferrugineus, capite magno rotundato ocello utrinque unico tribusque in vertice instructo nigrescente, pedibus robustis.—Long. lin. 1.

Hab. in cellulis *Anthophoræ retusæ,* apud Rutupium in Comitatu Cantio.

In the month of August 1831, while examining the dry clay bank beneath the ruins of the Roman castle at Richborough, near Sandwich in Kent, in search of the larvæ of *Meloë* in the cells of *Anthophora retusa,* with which the bank was thickly perforated, I found many cells filled with an abundance of minute parasitic larvæ, about one line in length, and apparently full-grown; but scarcely a cell contained any vestige of its original inhabitant, the larva of *Anthophora.* During that autumn and the following spring I met with these parasites so frequently in the cells, in different stages of development, that although I regarded them at that time as a new species of *Chalcididæ,* I took little heed of them, as my chief object then was to obtain the Meloës, and as I expected to find them on future occasions in equal abundance. Indeed they were so common as to occasion me considerable annoyance in finding the cells filled with these intruders instead of the larvæ of *Anthophora* or *Meloë.* I took care, however, to make very precise drawings of both sexes, in the perfect state, and of the larva, and also entered some notes of description. In the following years, 1832 and 1834, I again met with them, more especially on the 21st of August in the latter year, but not in such profusion as at first; but I have not been able to procure them since that period.

The *larva* (fig. 3) is completely apodal, of a subcylindrical form, a little attenuated at each extremity, and composed of fourteen segments. The head is small, like that of the wasp, or hornet, and the mandibles are short and acute. It occurred in the bee-cells to the number of thirty or fifty in each. I found it not only in the autumn, but also in the winter and early spring, in this state, but in some cells the larvæ had changed to nymphs before the month of September.

* These generic characters were published in full, together with short specific characters, in the 'Gardeners' Chronicle,' March 24, 1849, No. 12. page 183, in the report of the reading of the first part of this paper.

When the *nymph* (fig.6) state was attained, at the end of August, the change to the imago occurred in about ten or twelve days afterwards, and the perfect insect hybernated during the following seven or eight months. In most instances, however, no change took place until the spring, the period of hybernation being passed in the state of larva. The fact of the larvæ being full-grown at the end of August, and the cell otherwise entirely empty, seems to indicate that the species is carnivorous and feeds on the young of the Bee.

The *imago*.—The two sexes of this insect differ much in their anatomy and general appearance, and the dissimilarity is so great, that if they were found in separate cells, instead of being constantly together, they might readily be taken for distinct species. The males are heavy and creeping in their movements, scarcely ever making use of their wings, or attempting to escape, but the females are lively and very active.

Description of the species.—The *male* (fig.1) is of a deep yellow colour, very different from the female, which is of a shining bronze-green. It has a large rounded head, somewhat wider than the thorax, with a single ocellus on each side, instead of the usual large compound eyes of the tribe, and it has also a transverse row of three ocelli on the vertex. The antennæ (fig. 1 *a* & *b*), as I have shown, differ so much from these organs in the other sex, that they might easily be mistaken for those even of an entirely different genus. The prothorax is conical, and the head is supported on it as on a pivot. The mesothorax is somewhat quadrangular, and the scutellum very large. The abdomen in both sexes has seven distinct segments: it is sessile and of a suboval form. The legs are more robust in the male than in the other sex, the tibia and femur being well developed, and the tarsi are five-jointed. The wings are small, narrow, and extend backwards, when folded, as they usually are, to about one half the length of the abdomen. I never have seen the male unfold, or attempt to use them.

The *female* (fig. 2) is of a shining bronze-green colour, with a large head, and large compound eyes at the sides. The antennæ (fig. 2 *a*), as in most of the tribe, are each formed of a long basilar joint, about one half the length of the entire organ, the remaining portion composed of five joints being somewhat clavate. The prothorax and mesothorax resemble those of the male, as also does the abdomen, excepting that it is highly polished. The ovipositor is concealed. The wings are large, rounded, and iridescent, and the insect is exceedingly active on them. The legs (fig. 5 *d*) in this sex are yellow, and less developed than in the male. The number of females in each nest was as six or eight to one of the other sex, the number of the whole in each nest being from thirty to fifty.

I have been unable to find any description in the works of entomologists of this curious genus of parasites. Mr. Walker, our most assiduous monographer of the *Chalcididæ*, is unacquainted with it; and the only naturalist, so far as I can ascertain, who has made reference to an insect which possibly may have some affinity with this, is Mr. Westwood, who, in his work* published in 1839, mentions a species found by M. Audouin in France, in the nests of "*Odynerus*, *Anthophora* and *Osmia*," but he adds that "the species has not yet been described." Since then he has again alluded to M. Audouin's insect †, as

* Introduction to Modern Classification of Insects, vol. ii. part xi. p. 160. (March 1839.)

† Proc. Entom. Soc. Lond., July 5, 1847, p. xviii, in the Transactions, vol. v. part 3. 1848.

having "singularly distorted antennæ, and the wings almost rudimental," thus offering, he says, "a strikingly opposite analogy to other bee-parasites." But without describing M. Audouin's insect, either generically or specifically, or explaining in what its "strikingly opposite analogy" consists, this naturalist has proposed to designate that insect *Melittobia Audouinii*. A name thus given without a description, either generic or specific, cannot, however, be adopted; even if that insect should ultimately prove to be identical with mine. The necessity for precise description when a name is imposed will at once be perceived, in the fact that both Reaumur and DeGeer long ago found *Chalcididous* parasites in the nests of *mason-bees*, and yet, up to the present time, their species have not been clearly made out. Reaumur * found more than thirty larvæ of one species, and in other nests ten or twelve of a larger species. DeGeer † also found twenty specimens of another kind in a single cell, and which he reared to the perfect state. He remarks, too, that the larvæ of mason-bees are very subject to be destroyed in their cells by the larvæ of different species of *Ichneumon*. The species found by DeGeer seems to have been a *Pteromalus*, or nearly allied to that genus. These facts are interesting, as showing that mason-bees are infested by many parasites. The occurrence of Audouin's insect in the nest of *Odynerus*, as well as of *Osmia* and *Anthophora*, as stated, renders its identification with the insect I have discovered very doubtful. I have never found my species in any other than the nests of *Anthophora*.

The *habits* of this insect may be inferred from the peculiar organization of the male. From both sexes being found in the closed cells of the bee, and from the absence of a long ovipositor in the female, we may conclude that the eggs are deposited while the nest is being provisioned, or immediately before it is closed; and that, like the true *Ichneumons*, the parent either plunges her eggs into the body of the newly-hatched bee-larva, or attaches them to its skin. The bee-larva, like many other species similarly circumstanced, continues to feed, and grow, and supply nourishment to the parasites; and by the time it has consumed the whole of its provision, these also are far advanced in growth. When the young bee is entirely destroyed these are matured, and prepare for their change to the state of nymph, which they assume lying loosely in the cell, without spinning separate cocoons.

From the circumstance that although both sexes are found moving about freely in the cell, the male is by far the least active, and especially from the fact that his organs of vision are merely single ocelli, instead of large compound eyes, as in the other sex, I am led to the conclusion that impregnation is effected before the insects quit their habitation; because ocelli, being different in their structure from the individual parts of the compound eyes, are fitted only for near vision. The difference of structure consists in this: the cornea, or external surface of each part of the compound eye, which is individually as perfect, as an organ of vision, as the ocellus, or single eye, is less convex than the cornea of the latter; while the *chamber* of the eye, or space between the cornea and the termination of the nerve at the bottom of the structure, is of much greater length in the com-

* Mémoires pour servir à l'Histoire des Insectes, tome vi. part. i. p. 98. 12mo. Amsterdam, 1748.

† Mémoires, tome ii. part. 2. p. 887–8. pl. 30. fig. 23–25.

pound eye than in the single. The result of these two conditions is, that the compound eye is fitted for viewing objects at a considerable distance, but with little magnifying power; while the ocellus has great magnifying power, but is fitted only for viewing near objects. The male with his single eyes may thus be regarded as acute, but *short-sighted*, the very opposite of his partner. But this condition is essential to him, and fully sufficient, if, as presumed, the greater portion of his existence is passed in a closed cell, not half an inch in diameter, and from which perhaps he never wanders more than to the distance of a few inches. But stemmata or ocelli only would be insufficient for the other sex, who has not only to seek out the proper locality for her eggs, but also to elude the vigilance of the bee in whose nest she is seeking to introduce her own progeny. Instead, therefore, of mere stemmata, the eyes of the female are multiplied, and occupy, as in most other perfect insects, a large portion of the surface on each side of the head. Each of these aggregated eyes has a much greater length of sight, or distance of vision, than is afforded by the different structure of stemmata; while the multiplicity of these organs at one spot supplies to the insect at once long focal distance, or long-sightedness; and their multiplicity more than compensates for the narrowness of the field of each cornea.

The conclusions, then, which are deducible from the structure of the organs of vision seem to be, that whenever an insect is provided only with stemmata, the habits of the species, in that state of existence, are restricted to a few objects or requirements; or that the species is limited in perception and locality; while, on the contrary, when the organs of vision are multiplied and aggregated to form what we designate a *compound* eye, as in the imago state of most perfect insects, the field of vision, as well as the focal distance, or length of sight, and with these the range of the insect, are greatly extended.

Other facts in the comparative anatomy of this parasite confirm these conclusions. The short closed wings of the male, as noticed by Mr. Westwood in regard to the undescribed insect *Mellitobia* *, contrasted with the wings of the female, lead us to infer that the former sex rarely or never employs them in flight, and confirm the opinion that impregnation is the sole requirement for the male, and is effected within the cell.

This condition of the sexes affords a remarkable contrast to that of *Stylops*, which I formerly had the honour of bringing before the notice of this Society, Jan. 19, 1847 †. In that genus, as will be remembered, the worm-like female is sought out by the active male, in which the organs of vision, as in the equally active males of the Hive-bee and Glow-worm, are enormously multiplied, yet merely for one single act of existence—the continuation of the species.

Thus it may be seen that under every form of body, and of each individual organ, the special anatomy of a species is an index to its natural history and economy.

The second Chalcididous parasite, which I have found in the nest of *Anthophora*, is an insect of different character from the one just described, but equally illustrates the general views now proposed.

* Compare Mr. Westwood's remark on M. Audouin's insect above referred to, Introduction, &c., vol. ii. p. 160.
† Linn. Trans. vol. xx. p. 347–349.

Monodontomerus nitidus.

On the 12th of September, 1847, I detected, in several cells of *Anthophora retusa*, in a dry clay-bank at Gravesend, a number of white Hymenopterous larvæ, which at first I mistook for those just described. There were from twelve to twenty-five in each cell, apparently full-grown, and measuring each about one quarter of an inch in length. The body, in these larvæ (fig. 7 & 8), was formed of fourteen distinct segments, each divided transversely on the dorsal surface into two, and covered with exceedingly fine, scattered, brownish hairs. The head was small, and provided, as in all parasitic *Hymenoptera*, with short, transverse, corneous mandibles, and the larvæ had considerable power of locomotion, by the extension and shortening of the segments. The whole of the food that had been provided for the bee-larva was already consumed, and the bee-cell contained only the parasites and the dried tegument and head of the young bee, which seemed to have been starved. It was a question with me whether the bee-larva had not been killed by the other larvæ piercing it, and abstracting its fluids from without? This query, then, seemed to be answered by the circumstance that the number of the parasites was disproportioned to the size of the victim, which, had it served as food for them, would in all probability have been entirely consumed. Besides which, one anatomical fact showed that they were external feeders,—their bodies were covered with a few scattered hairs, appreciators of contact; a condition which I have never yet observed in the soft-bodied, internal-feeding larvæ of other *Hymenoptera*, and one which is as little required by them, as it doubtless would be inconvenient. Added to this, the great power of locomotion possessed by these larvæ,—which is neither possessed nor required by internal feeders, which remain almost constantly in the same spot,—suggested the opinion that it is on the food of the bee that these larvæ subsist, and not on the young bee itself, which may perish merely by deprivation of its proper nourishment. The larvæ also exhibited some indications of the formation of an anal outlet to the alimentary canal, which are not apparent in internal feeders at this stage of growth.

I preserved these larvæ, in the cells in which they were found, through the following winter, and although the remains of the bee were left with them in the cell, it continued untouched, and they exhibited no further change until the middle of May 1848. At that time some of the specimens gave signs of approaching transformation, in the shortened and more shrivelled appearance of their bodies. Each of the larvæ then spun some very delicate silk, in small quantity. Shortly before they were ready to enter the nymph state, the alimentary organs became perforated, and fæces were then passed for the first time during the whole period of the insect's previous existence. The fæces passed were little solid brown masses, that closely resembled the fæcal masses passed by the pollinivorous larva of *Anthophora*, which, like its parasites, as I have constantly found, passes nothing from its alimentary canal until it is about to change to a nymph. These fæcal masses seemed to indicate the supposed nature of the food,—pollen and honey; and to support the opinion formed of the habits of these larvæ from some points in their external anatomy. From twelve to twenty masses were passed by each larva: these were composed of the refuse of digestion and of epithelial cells accumulated during the period of feeding, and

retained in the digestive sac until the period of its perforation. In this way the food and abode of the insects are maintained pure and uncontaminated, and the digestive apparatus is completed, and the refuse of nutrition ejected only when the whole of the food has been consumed. Thus we find the most perfect concordance between the internal as well as external anatomy, and the functions and economy of the animal, exemplifying in every particular the harmony of creation.

I have stated that the digestive cavity is at first a closed sac. This species has enabled me to demonstrate the fact, and further to illustrate the manner in which it is changed from this form to that of a tube or canal.

On dissecting this larva, I found that nearly the whole interior is occupied by the digestive apparatus, which has the form of a bag, or rather of a Florence flask (fig. 9). Proceeding from the mouth and pharynx is a narrow short œsophagus (*a*), which suddenly enlarges into the common cavity (*b*): this occupies nearly the whole of the interior, and has extremely thick walls, formed of large packets of granulated cell-masses, inclosed between an exceedingly delicate muscular envelope on the external surface, and an equally fine, granulated membrane on the internal. It is divided from the œsophagus internally by a thick fold of its mucous and celliform tissues, which here constitute a complete cardiac valve (*c*), and prevent the regurgitation of the food. At the posterior, or larger end (*d*), it is connected with a column of cell-masses (*d d*), which have partially coalesced on the exterior, in the formation of a fibro-cellular envelope, and which, proceeding backwards, are united with the common tegument of the body in the fourteenth, or anal segment (*f*). In the centre of this segment, on the external surface, the skin and muscles separate at a definite point in the formation of the anal outlet. When the change is about to commence, the cell-masses that form the cæcal end (*g*) of the cavity also separate and recede, and this separation extends backwards to the fourteenth segment in the axis of the column of cells. By the centrifugal expansion of these, and the consequent widening of the tube, the canal is completed, and quickly becomes lined with a delicate membrane, like the interior of the larger cavity. The digestive organ is enveloped in a thick layer of granulous matter, in which the Malpighian vessels (*h*) and the organs of reproduction are developed. At its anterior and inferior surface it covers two large sacs, the silk-glands (*i*). These are the first developed organs of this class of structure, and are needed thus early for the production of the silk which the larva spins before its change.

The *nymph state* (fig. 11) was assumed by two of my specimens at the end of May. On the 30th of that month I found that three others also had undergone their change, and that the remaining ones were preparing to do so. The nymph had the usual form of the tribe, and the sexes were now for the first time distinguished. The male nymph was smaller, more slender, and with the apex of the body acute; while the female was much larger than the male, with a short projecting keel at the posterior of the abdomen—the ovipositor.

The *imago* (fig. 12).—On the 27th of June, about four weeks after entering the nymph state, one of the female specimens threw off its envelope and became perfect, and proved to be a species of the genus *Monodontomerus*. A few days afterwards one of the males appeared; and in the course of a week, before the 3rd of July, most of my specimens had become perfect.

Of fifteen specimens allowed to complete their changes, there were only two males, with thirteen females. The remaining specimens I had preserved in their larva and nymph states for dissection. This small number of males coincides with the small number of this sex in other bee-parasites; but the deficiency in numbers is fully compensated for by the activity of the individuals.

The fewness of the males, and their great activity, lead me to believe that the females are impregnated, not *before*, but shortly after they have left the cell, and in the hot sunshine. Like the *Chrysididæ*, these insects are active only in strong light. Both sexes of my specimens always became dull and motionless when removed from the light; but when exposed to the sun they immediately resumed their activity. They seem to live but a short period in the imago state. The males died within a few days, and the females in about a fortnight.

I have proposed for this species the name of *nitidus* *, from its elegant and glistening appearance. It may be described as follows:

Monodontomerus nitidus.

Male.—Head and thorax brilliant shagreen, with fine short hairs: head broader than the thorax, face bluish; labrum emarginated; eyes and ocelli large, dark brown; antennæ 11-jointed, basal joint coppery. Prothorax compressed and slightly excavated at the sides. Metathorax and scutellum large. Abdomen green bronze, hairy, petiolated, very much compressed at its base, and keeled on the ventral surface; first and second pairs of thighs green; third pair large, copper-coloured; tibiæ and tarsi fuscous, very hairy. Wings hyaline, hairy, with black costal spot. Length two lines and a half.

Female (fig. 12).—Head and thorax brilliant shagreen, hairy: head large; face blue, punctured; eyes and ocelli large, brown; antennæ pubescent, 11-jointed, with the basal joint coppery, as in the male. Thorax compressed laterally. Scutellum very large. Thighs green, shining. Tibiæ and tarsi hairy, fuscous, with an acute spine at the articulation of the tibiæ. Abdomen coppery, polished, with a few white hairs, subsessile, compressed at its sides, and strongly keeled; ovipositor exserted, longer than the abdomen, and very acute. Wings dusky iridescent, hairy, and with dark marginal spot. Length of body two lines †.

From the length of the ovipositor in this insect, we may conclude that the female does not enter the bees' nest to deposit her eggs; but that she perforates the cell and conveys them into it, after the cell is closed, and probably after the young bee is hatched. Every part of the anatomy of this insect, as of the preceding, and of every other species when attentively considered, will thus be found to exemplify its general economy, and to indicate how closely the one is connected with the other,—how intimately associated is the instinct of a living being with special conformations of its organism. Some other families of Hymenopterous parasites are marked instances of the unfolding of peculiar instincts subsequent to the development of particular structures. Amongst these we may notice two of the true *Ichneumonidæ*, *Paniscus virgatus* and *Ichneumon Atropos*.

* This name was proposed for the insect at a Meeting of the Entomological Society, on the 3rd of July, 1848, and the discovery of the larva in the nests of *Anthophora retusa* was then mentioned. See Proceedings, Ent. Soc. Trans. vol. v. part 5. p. xlii. 1848.

† Mr. Walker has recently re-described this species as "*Monodontomerus Anthophoræ*, Newp." See Ann. and Mag. of Nat. Hist. vol. ix. No. 49. Jan. 1852, p. 43.

Postscript to the foregoing Section of this Paper.

Read May 1, 1849.

I am desirous of appending a few remarks to the section of this paper that has already been communicated to the Society, before proceeding with the remainder.

These refer to the second bee-parasite described, and provisionally named *Monodontomerus nitidus.* The parasitism of insects of this genus on *Anthophora* had not previously been ascertained. *M. obsoletus* had been suspected of infesting the genus *Osmia* *, like one of its affinities †, but its larva, so far as I am aware, was unknown. I found the larva of *M. nitidus* in the nests of *Anthophora,* on the 27th of September, 1847, and mentioned the fact to an entomologist, Mr. F. Smith, who, some time afterwards, as he himself informed me, obtained specimens of it from the same locality. From a note on its habits, which he has recently communicated to this Society ‡, it appears that the larva is carnivorous, and feeds on the bee-larva, and not on its food, as I had believed. I am thankful for this correction of observation. The mistake arose in my haste to furnish part of this paper for reading to the Society by a given time, which obliged me to forego an examination of the parts of the mouth, which are difficult to observe, and compelled me to rely on the appearance of the fæces, and on the fact of having found my full-grown specimens in the cell of the bee with the dried-up remains of the bee-larva. I have now made the required observations on the oral organs, and also have microscopically examined the contents of the digestive apparatus, and these lead me to agree with Mr. Smith in regarding the larva as carnivorous, and not as pollinivorous. The mandibles are slender, arched and acute, and are fitted only for piercing, and not for comminuting food; the labium and maxillæ are thick, large and membranous, somewhat like those of the larva of *Paniscus.* The contents of the digestive apparatus I found to consist of large and small nucleated cells, consolidated together, and darkened in appearance, conditions induced probably by admixture with secretions from the parietes of the apparatus during digestion.

Thus further examination of this larva tends but to confirm, instead of to confute the general view which I have constantly maintained,—that structure, when carefully and accurately investigated, is an infallible index to function and habit. My incorrectness in opinion as to the particular kind of food of the larva of *Monodontomerus* was the result of hurried and incomplete inquiry, and it is now rectified by direct observation on the habits of the insect, and by closer attention to its anatomy. Yet the main object of this paper was but little affected by the error, my aim being to show not merely that Hymenopterous parasites may differ in their kind of food, but the more general fact of a concordance between structure and kind of life;—and also that whether the Hymenopterous parasite is shut up in the same cell with an insect that continues to feed, or whether it preys on the surface or interior of such insect, its alimentary canal is closed and incomplete until it has ceased to take food and has acquired its full size, when the canal becomes perforated, and allows a passage for the ejection of the refuse of nutrition; the necessity for this late completion of the organs of digestion having reference to the preservation of the food of the parasite in a condition fitted for its proper nourishment.

* Westwood's Introduction, &c., vol. ii. p. 160. † *Id.* ‡ Proceedings, vol. ii. p. 29.

PART II. ICHNEUMONIDÆ.

Read May 1, 1849.

Paniscus virgatus, Fourc.

The parasites of the genus *Paniscus*, and their affinities *Ophion*, which are some of the most active and percipient of insects in their perfect state, are examples of one of the very lowest forms of life as larvæ, as well as of one of the most curious modes of nutrition. In the earlier stages of growth they more resemble cotyledonous vegetables, in general appearance, than animal organisms which are destined to become some of the most perfect, and most active of their Class. I have traced *Paniscus virgatus* from the bursting of its egg to its assumption of the imago state, and have watched its growth and the formation of its tissues.

The earliest notice I am acquainted with on the habits of an insect of this family is of *Ophion luteum*, by Gœdart *, who found five specimens of the imago produced on the 29th of June from the hard cocoon formed in September of the previous year, by the larva of *Cerura vinula*, L. Bonnet † afterwards, as quoted by DeGeer ‡, made some observations on the singular economy of this insect. He remarked that the eggs of *Ophion* are attached to the outside of the body of the caterpillar of the Puss-moth, by a short pedicle or footstalk inserted into the skin, and that the parasite when hatched is nourished on the outside of the body, still attached to its shell and pedicle like a vegetable growth. DeGeer § found the same insect on the Puss-moth larva, and ascertained that several individuals subsist on the same caterpillar, which dies of exhaustion after it has formed its hard wooden cocoon. More recently the eggs of this genus have been the subjects of a memoir by Dr. Hartig, as mentioned by Mr. Westwood ||, but this memoir I have not yet seen. I do not pretend, therefore, to claim entire originality for the few observations which I have made on *Paniscus*, but merely to state what I have myself observed, in accordance with the views I have proposed.

On the 26th of September, 1847, I found many nearly full-grown larvæ of the Broom-moth, *Mamestra pisi* (fig. 13), feeding on that plant in the hot sunshine. On the following day I detected a number of little shining black-looking bodies (*a*) on one of these larvæ, attached to different parts of its three thoracic segments. On examining these bodies more closely, I found to my surprise that they were black shining eggs (*a*), inserted at one end into the skin of the caterpillar. These eggs were somewhat oval, or rather pear-shaped, the attenuated footstalk being lodged under the skin. There were eight thus attached. But what fixed my attention closely was, that most of the eggs had already burst, or were in the act of bursting longitudinally (14 *c*), precisely as I have formerly seen and described in the eggs of the *Iulidæ* ¶. Each egg had divided in the middle line, at its anterior extremity, and the two halves of the shell were separating like the cotyledons of the seeds of

* Métamorphoses Naturelles, 12mo, tom. ii. p. 162. pl. 37. À la Haye, 1700.

† Mémoires de l'Académie des Sciences de Paris.

‡ Mémoires, tom. ii. p. ii. page 851.

§ *Ibid.* p. 852, 853.

|| Introduction, &c., vol. ii. p. 146.

¶ Phil. Trans. 1841.

leguminous plants, whilst the head of the little white larva was slowly passing out between them (14 *a* & *b*), like the germ-roots, to become affixed by its mouth to the skin of the caterpillar, the body being retained within the shell. As the parasites became attached, the fated caterpillar moved about with increased rapidity, twisting and turning its body in every direction, and evidently endeavouring to get rid of its new-born enemies, but to no effect. The little beings, securely affixed by their shells, giving no evidence of sensation, and scarcely even of vitality, were unaffected by these endeavours to displace them, and retained firm hold. The cleavage of the shell was chiefly on the under surface, so that the two halves formed a kind of bivalve covering or cloak to the larva, and clasped its body as the head emerged. The head at first was the only portion of the larva that was exposed. But the little creature grew rapidly, deriving its nourishment by slight puncture and suction through the skin of the caterpillar, with scarce an abrasion of the surface. The rapidity of its growth in this way was truly astonishing, the whole of the nutriment thus imbibed being appropriated to its increase, excepting only the very little expended by cutaneous transpiration; for respiration at this early period can scarcely be proved to have commenced, as I was unable at this stage to detect the respiratory organs, while the digestive cavity, as we have already seen in other parasites, was imperforate. Within *two hours* from the bursting of the shell there was a marked increase of size in the larva. In the course of the *first day* the prothorax and the head were extended from the shell, and early in the *second day* the three thoracic segments, as well as a large portion of its ventral surface, were exposed, the larva (fig. 15) then being nearly twice its original size in the ovum. When examined by a lens it seemed to be almost entirely formed of an immense stomach, connected with the mouth by a short and very narrow œsophagus, as in the larva of *Monodontomerus*. The motions of the stomach, vermicular and incessant, were distinctly seen through the tegument. As the insect increased in size, it was more and more extended from the shell. Its anterior part grew the most rapidly, the largest segment being the first, or prothoracic.

It was not until after the completion of the second day that I was able to detect the respiratory organs through the tegument, although I had previously sought for them with much care. The little vegetating being then seemed like an embryo, which,—instead of deriving its means of growth, like other embryos of its class, in the unburst egg by imbibition of fluid from without, through its shell and membranes,—had been prematurely exposed by the sudden rupture of its envelope, and left to perish, or to absorb adventitious nourishment from other bodies. I could not help regarding it among insects as the representative of the embryo Kangaroo among quadrupeds, prematurely liberated from its fœtal coverings, and extruded from the body of its parent, to continue existence attached externally to the teat in the marsupium. But still more closely did it resemble the embryo of the inferior *Myriapoda*,—the *Iulidæ*, in which the young, after bursting its shell longitudinally, as in *Paniscus*, is detained within it, and continues to grow by imbibition of nourishment through its membranes from the surrounding medium. There is, however, this difference. In the *Iulidæ* the retained embryo is inclosed in its membranes after the shell is burst, and does not throw them off until it has acquired organs of locomotion and is able to move about and seek food. But the young *Paniscus* bursts its

membranes with its shell, although it is completely apodal and incapable of locomotion, and has to derive nourishment, not by simple endosmosis through its fœtal envelopes into the tissues of its body by similar means, but by the direct abstraction of fluid from another living body into its own. To ensure this, the larva requires to be attached by its terminal segments to its shell during the whole period of its growth, and like the larvæ already described, it passes no fæces until it has attained its full growth, and becomes detached from its shell, to prepare for its change to a nymph.

After the second day I was accidentally prevented for some time from making any very precise observations on these insects, further than noticing that they grew rapidly from day to day, and that they retained their connexion with the shell.

On the 4th of October, the *ninth day* of their existence, I was enabled to resume my examinations of them, and then found that several of them had perished, and that three only remained healthy and thriving. The caterpillar on which they had fed had become shrunken and wasted, but still retained sufficient irritability and muscular power to contract its body with a quick lateral motion when touched. The larvæ that remained healthy were now at least twelve times their original size (fig. 16). The head (16 *a*) of the larva, which at first was the most ample region of its body, was now the smallest, relatively to other parts which had increased more rapidly, and but little exceeded the size of the ovum. The parasites were attached, one on the dorsal surface and one on each side of the caterpillar, the latter one coiling round the inferior surface of the thoracic segments (fig. 17). Their bodies, enlarged and fattened, were of a dark pea-green colour, and were formed each of fourteen segments, all of which, more especially the anterior ones, were distinctly marked. The stomach in each was in a state of incessant to and fro vermicular motion, and had become enveloped in a thick tissue of little white follicles, which have been regarded as the rudiments of fat-vesicles. No anal outlet had yet been formed, nor was there, so far as I could discover, any perforated intestine. In the interval of seven days, during which I had been prevented from following up my observations, each larva had three times cast its tegument. This, I believe, is the first time that the soft-bodied Hymenopterous larvæ have been noticed to undergo this change. These larvæ, therefore, as I have already pointed out, are not exceptions, as they have been suspected to be, to the general rule of development in hexapods, in so far as refers to the casting of the skin; although, as the body is still connected with the egg-shell, the cast teguments are not entirely got rid of until the larva is detached to become a nymph. The skin is fissured in *Paniscus*, as in other larvæ, along the dorsal surface of the anterior thoracic segments, and is gradually removed from the dorsal, lateral, and inferior surfaces of the head and succeeding segments, by the growth and expansion of the new tegument beneath it, the fissure being extended, and the covering slipped off from above downwards and backwards, as much by the rapidity of growth in the parts beneath, as by the occasional slight muscular contractions of the segments. When I re-examined my specimens on the *ninth day*, neither of the cast layers had been removed further than to the posterior segments of the body, which they partially inclosed. The *first shed* skin (fig. 16 *a*) was attached to the anal segment, and enveloped this part, surrounded by the shell, and covering the inferior surface. The *second* (*b*), within the first, but larger and more corrugated, partially sur-

rounded the twelfth and thirteenth segments: and the *third* (*c*), the deciduation of which I had the good fortune to witness, while examining the larva for other purposes, was internal to, and partly covered by, the second, and was not forced back further on the ventral surface than to the *ninth* segment, although, like the preceding, it was entirely removed from the dorsal surface. The whole thus formed a kind of treble sheathing to the posterior segments of the body, until the period when the larva, full-grown to repletion, was to prepare for its transformation, become detached from its shell, and leave its deciduated coverings in connexion with it. On the *tenth day*, October 5th, the larvæ had further increased in size, were more raised from the body of the caterpillar, and lay coiled up in a more circular form. Each one was still attached to its egg-shell, although now more than twenty times its size, and each adhered to the caterpillar by its oral organs, exhausting and impoverishing it of its juices. The skin of the parasite again appeared tense and dull, as when about to be cast. The head and thorax had a whiter and more fibrous appearance, the stomach was less easily distinguished through the tegument from other viscera, excepting at intervals, and the heart was seen in motion along the dorsal surface, but with little regularity in its contractions. Its movements appeared to be greatly influenced by the motions of the digestive apparatus, which seemed to induce the tissues around it to contract, and thus excite a reflected action in the circulatory organ, the movements of which appeared to be greatest in the middle of its chambers. The tissue which has hitherto usually been regarded as the *adipose*—and which I may hereafter have occasion to notice more particularly—was now much extended and augmented in size, and the respiratory organs, although extremely simple, were become well marked. On the *eleventh day* the larva was still larger, and became detached from the egg-shell; but whether this resulted from accident, or from the completion of its growth, I was not then able to determine. Its tegument had become more opake, and there were tubercular projections at the sides of its abdominal segments, immediately below the line of longitudinal tracheal vessels. On the *twelfth day* I found that the separation of the specimen from its shell was accidental and premature, and that the larva was unable to re-affix its oral organs to the skin of the caterpillar and perished. This is usually the case when a larva is prematurely detached; and this result explains the necessity for the continuance of its connexion with the egg-shell, which, as DeGeer has observed of the eggs of *Ophion*, is so firmly inserted into the caterpillar that it cannot be removed without lacerating the skin.

My further observations were now continued on the other specimens of the same brood, which had been more slow of growth. On the *fifteenth day* one of these was mature, and separated from the shell, leaving its cast teguments forced into a little mass attached to it. DeGeer * formerly noticed that the larva of *Ophion* left something connected with the egg-shell, but he does not appear to have been aware that it was the entire cast skin of the larva. My specimen of *Paniscus* now measured somewhat more than half an inch in length, was of a curved form, and was smallest at each extremity. Mr. Westwood † has already indicated this as the general form of body of the larva of this tribe of parasites, and has mentioned that they have lateral fleshy tubercles. He has described the parts of the mouth as consisting of "two obliquely deflexed horny mandibles, very small, slender,

* Mémoires.

† Introduct. vol. ii. p. 147.

and acute, beneath which is a curved fleshy lobe, formed by the union of the dilated maxillæ and labium." In this account he is perfectly correct. But while challenging the description given by Reaumur of the head of the larva, he appears himself to have fallen into the singular error of mistaking the rudiments of the future antennæ for ocelli. He says *, "The head is furnished with two distinct round points—resembling ocelli," but he makes no allusion to the existence of antennæ. No organs of vision exist in any of the parasitic *Hymenoptera* at the "points" he has indicated in his text and figure of the head of these larvæ, the parts referred to being the apices of the antennæ of the future imago. I have traced the antennal nerves into these parts in the larva of *Ichneumon atropos*, which closely resembles in this respect that of *Paniscus*. The small size and deflection of the mandibles partly account for the difficulty which this larva has in re-attaching itself to the caterpillar when detached from its shell, and the consequent necessity for this attachment for its preservation,—premature removal resulting in starvation, as with my first specimen. My second specimen, which left the shell only when matured, I placed on some light mould, in a covered glass vessel, to observe its changes. I expected to have seen it bury itself in the earth, knowing this to be the habit of the larva on which it feeds; but in this I was disappointed. Its instincts were more limited and imperfect than I had imagined. On the day after placing it on the mould, it was lying in a slight hollow on the surface, made by contracting and turning its body, and was in the act of spinning a delicate web of silk, under which it was lying, and where I hoped to have seen it change to a nymph. It attached a few grains of earth to the inside of the web, and between the threads scattered here and there, like the particles of earth interwoven with its threads by the caterpillar of *Mamestra*, but after remaining at rest for a couple of days, I found it discoloured and dead.

Thus checked in my observations, I had no hope of being able to complete this inquiry by tracing the insect to its imago state, until, on the 6th of April, 1848, I found, on examining the earth in a breeding cage, in which I had kept many larvæ of *Mamestra pisi*, to obtain the pupæ of that insect,—in several earthen cocoons formed by the caterpillar, —from two to three cylindrical leather-like cases of a black colour, applied so closely together that their walls formed angular surfaces, precisely like the cells of a honeycomb, or wasp's nest. There were from two to three of these cylindrical cases in each earthen cocoon of *Mamestra*. Each cylinder measured about six-tenths of an inch in length. In some cocoons there were three cylinders, and in one only I found four. In the latter instance they were smaller than when the cocoon contained but two, as if the inmates had not been sufficiently fed. This was markedly the case with two of the four specimens found together, which were scarcely more than one-half the size and length of the others. Each of the cocoons of *Mamestra* was completed in the usual mode of this larva, its earthen walls being smoothed on their interior, agglutinated together, and lined with silk; and each contained, besides the cylinders of the parasitic insects, the dried-up remains of the caterpillar.

From these facts it seems to follow, that the economy of the parasite is this: the parent Ichneumon-fly deposits her eggs on the caterpillar when this is nearly full-grown, and

* Introduct. vol. ii. p. 147, fig. 76. 14, p. 140.

will soon enter the earth, which it does, as I presume must have been the case with these insects, while the parasites are very young and small, otherwise they may be injured or detached while the caterpillar is burrowing and making its cell. The fated insect, exhausted by the parasites, has but sufficient strength to complete and tapestry its earthen chamber before it dies, leaving its newly-formed abode to the occupation of its enemies, which grow rapidly, as we have seen, pass through the changes I have traced, and then form their own cocoon in which they are metamorphosed to nymphs.

On examining one or two of the cylinders at the time of obtaining them in the beginning of April, I found that the inmates had very recently changed to nymphs (fig. 18).

On the 8th of May one of these assumed the imago state (fig. 19), but escaped on my incautiously opening the box that inclosed them. On the 14th two more appeared, and I now had the means of identifying the species. It proved to be as I have stated, *Paniscus virgatus*.

It is probable that these insects may have come forth at a period earlier than in their natural haunts, having been kept in a warm room, and the temperature of the season, at the time of their evolution, being considerably higher than usual. It is worthy of remark, however, that the moth, or the larva of which this *Paniscus* is a parasite, kept during its pupa state under precisely similar circumstances, had already made its appearance a week at least previously; so that, under similar conditions of locality and temperature, the parasites came forth at the latest period.

DESCRIPTION OF THE FIGURES.

Tab. VIII.

Fig. 1. *Anthophorabia retusa,* Newp. (male).

a. Antenna of the male, upper surface.

b. Antenna of the male, inferior surface.

Fig. 2. *Anthophorabia retusa* (female).

Fig. 3. The *larva* of *Anthophorabia retusa.*

Fig. 7. Larva of *Monodontomerus nitidus,* Newp., early stage.

Fig. 8. Larva of *Monodontomerus nitidus,* Newp., full-grown.

Fig. 9. Alimentary canal of the larva.

(*a*). Œsophagus.

(*b*). Stomach, or digestive cavity.

(*c*). Cardiac valve.

(*d*). Pyloric valve.

(*e*). The undeveloped celliform future intestine.

(*f*). Future anal outlet.

(*g*). Cæcal end of the digestive cavity, the centre of which is the future pylorus.

(*h*). The Malpighian vessels or bile-ducts.

(*i*). The silk-glands.

Fig. 10. Inferior surface of the head of the larva of *Monodontomerus.*

Fig. 11. The nymph (male).

Fig. 12. The imago (female).

Fig. 13. The larva of the Broom Moth, *Mamestra pisi,* infested with the eggs (*a*) of the Ichneumon fly, *Paniscus virgatus.*

Fig. 14 *a* & *b.* The larva of *Paniscus* recently burst from the egg and still retained between the two halves of the shell.

Fig. 15. Larva on the second day.

Fig. 16. Larva on the ninth day.

Fig. 16. Magnified larva to show the deciduation of the skin. *a, b, c.*

Fig. 17. The dead and exhausted larva of *Mamestra pisi,* with the parasitic larva of *Paniscus* attached.

Fig. 18. The nymph of *Paniscus* in its oval cocoon.

Fig. 19. The imago.

IX. *Further Observations on the Genus* Anthophorabia.

By GEORGE NEWPORT, *Esq., F.R.S., F.L.S. &c.*

Read February 3, 1852.

HAVING had the good fortune, in September last, to re-discover in the nests of *Anthophora*, at Gravesend, the Chalcididous parasite *Anthophorabia*, which, twenty years ago, I found at Richborough in Kent—and an account of which is given in my paper on the *Chalcididæ* and *Ichneumonidæ*—I feel it necessary to offer a few additional observations on this insect; since one of the most remarkable peculiarities of its male sex—and on account of which the *genus* was characterized and named in that paper—has been denied to be a fact—the denial being printed in the "Proceedings" of the Linnean Society*, and elsewhere†. The peculiarity to which I allude is the possession of a single stemmatous eye, in the place of a compound eye, at the sides of the head in the male.

At the time of communicating my paper on the *Chalcididæ*, &c., to this Society, I was not in possession, as was then pretty well known, of specimens of the insect itself, but only of delineations which I had made in the year 1831 from living specimens, and at which time, and for two or three years afterwards, I found the insect in such abundance that, expecting to be able to obtain it at pleasure, I neglected to preserve it. Through the long interval of time which has since elapsed, up to September last, I have not again been able to find it. It was upon the very fact of the existence of stemmatous eyes, in the place of compound ones, in this insect, that some important physiological deductions in my paper are founded; and thence it was reasonable to expect that every inquirer would have believed that of this fact, at least, I must have been quite certain, before venturing to deduce conclusions. Yet this has been repeatedly questioned by Mr. Westwood, and even in the "Proceedings" of the Society itself ‡.

As I am now in possession of specimens of the insect, which I beg to lay before the Society §, I am enabled to prove that not only do stemmatous eyes, instead of compound ones, exist in the male, as I have stated, but also that the principal characters given in my paper as marking the genus,—the enlargement and excavation of the basilar joint of the antenna, as well as the enlargement of the middle joint,—are correct. The male has a single stemmatous eye on each side of the head, and three stemmata on the vertex, so

* Vol. ii. p. 37.

† Gardeners' Chronicle, May 12, 1849, p. 295. Annals and Mag. of Nat. Hist. (2nd ser.) No. 19, vol. iv. p. 39, July 1849. Trans. Entom. Soc. vol. v. part 7, 1849, p. lxv.

‡ "The asserted possession of stemmatous eyes by the male was regarded as erroneous, there being no instance of such a structure, throughout the whole range of winged insects, whilst it is essentially a character of some of the wingless tribes."—Westwood in Proceedings of the Linnean Society, vol. ii. p. 37.

§ Specimens of both sexes of the insect were exhibited at the Meeting.

that, with the insect before us, we are now enabled to demonstrate that this little creature really does possess the eyes stated*. It is but just, however, to mention, that with regard to some other details of less importance, my former description admits of revision; but any occasion for this, although asserted, could only have been guessed at as vaguely as with regard to the eyes, by those who have never seen my insect. Thus I now find that the club of the antenna, in both sexes, is formed of a plurality of closely-united immovable segments, instead of being but a single joint; a circumstance which affects the declared *number* of parts of which the antenna is composed; and the possibility of which I have elsewhere admitted†. Further, the number of joints in the tarsi may either be regarded as *five*, as I have described them, if, as anatomists, we consider as a distinct joint the pad-like terminal portion of the foot; or as *four* only, if this part be discarded, and the number be computed in the way usual with entomologists.

With regard to the supposed identity‡ of *Anthophorabia* with the insect mentioned in my paper of the 20th March, 1849, p. 64, on the *Chalcididæ*, and which had been *named Melittobia*, but which, up to that period, had not been described§, there cannot be much difficulty in arriving at a conclusion in the negative; if the description in the accounts given by the entomologist who has since repeatedly characterized the latter insect be correct. Thus the male of *Anthophorabia* has stemmatous eyes, while that of *Melittobia* is described as having "eyes and stemmata wanting‖," or as "omninò cæcus¶," or "cæcus**." And again, the male of *Anthophorabia* has the middle joint of the antennæ "large and globose" or subangulated, while that of *Melittobia* was first stated to have "2nd and 3rd joints small, nearly equal, 4th, 5th and 6th very small and subannulose††," and afterwards these characters were revised by the omission of all reference to the second and third joints, the statement being simply "articulis 4to, 5to et 6to minimis‡‡." So that, presuming these several descriptions to express the fact, the question must be looked upon as decided.

Thus much then with regard to the identity of the *genus Anthophorabia*. In respect of the *species* there appears to be even less difficulty, *Anthophorabia retusa* being described both *generically* and *specifically* in my former paper, while no *specific* characters whatever have even as yet been published of *Melittobia Audouinii*.

I now propose to revise the generic description of *Anthophorabia* in the following manner:—

Fam. CHALCIDIDÆ.

Gen. Anthophorabia, Newp.

Fem. Caput latitudine thoracis. *Antennæ* 9-articulatæ, pilosæ; articulo 3tio ad 6tum subæqualibus; reliquis clavam solidam ovalem efformantibus. *Thorax abdomen*que æquales. Tarsi (4-?) 5-articulati in utroque sexu; articulo 5to minimo pulvillo simili, ferè obsoleto.

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* Page 63. † Ann. and Mag. of Nat. Hist. August 1849, p. 123. ‡ Proc. Linn. Soc. vol. ii. p. 37.

§ See Mr. Westwood's "Introduction," &c., vol. i. p. 18. "The species has not yet been described." Also, Trans. Ent. Soc. vol. v. part 3, 1848 (Proceedings), p. xviii. ‖ Gardeners' Chronicle, May 12, 1849, p. 295.

¶ Transactions of the Entomological Society, vol. v. part 7, p. lxv. 1849.

** Proceedings of the Linnean Society for May 1, 1849, vol. ii. p. 37.

†† Gardeners' Chronicle, *ubi suprà*. ‡‡ Trans. Ent. Soc. and Proc. Linn. Soc. *ubi suprà*.

Mas. Caput magnum. *Oculi* stemmatosi. *Antennæ* 10-articulatæ; articulo 1mo globoso, minutissimo; 2do arcuato, magnoperè dilatato, dimidio anteriore subtùs excavato; 3tio magno; 4to adhùc majore, globoso v. subangulato; 5to, 6to, 7moque minimis, cyathiformibus; 8vo, 9no, 10moque auctis, clavam solidam ovalem efformantibus. *Alæ* abbreviatæ.

As the specimens which I now possess afford some specific characters which I do not remember to have observed in the specimens formerly obtained at Richborough, and as I do not possess any of those to compare with them, I propose to name the species I have obtained at Gravesend, *provisionally*, in the event of its proving to be distinct, *Anthophorabia fasciata*, and to describe it as follows:—

ANTHOPHORABIA FASCIATA; *Mas.* Fulva, fasciis 5 transversis abdominalibus saturatioribus, antennarum articulis anterioribus oculis prothoracis margine posteriore maculâque subalari utrinque in mesothorace nigrescentibus, pedibus subarcuatis robustis ambulatoriis, trochantere femorumque paris secundi parte terminali subtùs spinulis minutis densè barbatis, tibiis tarsisque omnibus fortiter spinosis.—Long. lin. 1.—*Fœm.* Nigro-æenea nitida, lineis 2 longitudinalibus in mesothorace scutelloque albidis, abdomine ovali elongato acuto fasciis transversis saturatioribus pilis albidis marginatis, oculis rufescentibus, pedibus flavescentibus, femoribus saturatioribus, tibiis rectis elongatis pilosis, tarsis pilosis fortiter spinosis.

Hab. in nidis *Anthophoræ retusæ*, juxta Gravesend in com. Cantio.

These insects were found while myself and a friend were searching for the larvæ of *Monodontomerus nitidus*, on the 14th of September, 1851, at Gravesend; and although met with in only one bee's nest, I was fortunate in securing nearly one hundred and fifty specimens. Most of these were still in the nymph or pupa state, but some of them had already become imagos. On examining them on the following day, I found that several more had recently changed; and while I was engaged in watching them, I had the satisfaction to observe two males throw off their coverings. Having placed the whole in a shallow vessel covered with glass, I was enabled to watch their proceedings. These males began immediately to traverse round the interior of the vessel leisurely, but very assiduously, touching and turning many of the yet undeveloped female nymphs with their antennæ. Occasionally they raised their rudimentary wings, but made no attempt to fly, or even to leap, as the females frequently do, although they were in no way confined for room. In this manner they continued to roam about, without making the slightest effort to escape, their sole attention being evidently directed to the unhatched females.

The males appear to be very few in number in proportion to the females, as out of the hundred and fifty specimens obtained I could only find eleven. They are also very short-lived, as the whole of those which came forth in the afternoon of the day subsequent to that on which they were found, were dead on the following morning. The females were much longer-lived, and not only crept about freely, but occasionally leaped to a considerable distance.

I was not able to observe any direct communication between the sexes, notwithstanding the apparent attentions of the males in the way I have mentioned. Yet there afterwards appeared reason to believe that some of the females had been fecundated, probably, as for-

merly suggested, while they were still included in the closed bee's nest. I had placed nearly a hundred females, including some which had been hatched in the closed cells, and others which I afterwards saw change from the nymph, in a glass tube, secured, as I believed, completely with a cork. For a few days the insects remained quiet, occasionally voiding fæces; thus showing that the females, at least, are destined to take food, and survive for some time. But at the end of ten days or a fortnight I found, to my surprise, that the glass tube had become nearly empty, almost the whole of the insects I had inclosed in it having escaped, although the cork had not once been removed during the interval. They had contrived to insinuate themselves into slight depressions in the sides of the cork, between it and the glass, as I found one or two thus in the act of escaping; while others, which had obtained their liberty, were noticed in different parts of the room, one or two being found in the window and elsewhere. This fact, trifling as it is, is interesting, as probably illustrative of the penetrating, fossorial habits of the species, and, with other circumstances, leads me to believe that the insect penetrates into the closed cell of the bee to deposit her eggs on the nearly full-grown larva within.

Happening about the 20th of November, seven or eight weeks after this observation, to examine a box in which I had placed some larvæ of *Anthophoræ* in partially opened cells, I noticed a small parasite attached to the surface of one of them, and which, from its size, I at first mistook for a larva of *Monodontomerus*. But on opening the box again, about a week afterwards, I remarked that the parasite had but slightly increased in dimensions; while, on closer examination, I found within the cell, beside the bee-larva, three perfect female *Anthophorabiæ*; and on watching these for a few minutes, two of them seemed to be engaged in oviposition. I then saw that instead of there being only one or two parasitic larvæ attached to the skin of the young *Anthophora*, there were many, in very different stages of growth; from that which I had first observed, and which had nearly attained its full size, to others which did not exceed the fifth of a line in length. I now concluded that these were not the larvæ of *Monodontomerus*, as I first supposed, but of *Anthophorabia*, an opinion which was confirmed by subsequent examination with the microscope; and this further induced me to think that the females noticed were, as they appeared to be, depositing ova. I did not observe any of these larvæ parasites on the young *Anthophoræ* at the time of procuring them from their natural haunts in September, when the cells were first broken and their inmates exposed, at which time they appeared to be quite healthy. Nevertheless, one or two of the parasites now upon them were nearly full-grown, and measured nearly a line in length, while others were so small as to be hardly recognizable; thus giving further reason to suppose that the eggs had been deposited and hatched at different periods. The way in which this appeared to be capable of explanation was, that some of the female *Anthophorabiæ* which had escaped from the glass tube, as just stated, had sought out these larvæ of *Anthophoræ*, which lay exposed in their cells in the box near to where I had placed the tube from which they escaped, and insinuating themselves into the box, had at different times deposited their eggs on the young bee-larva; and that, owing to the gradually decreasing temperature of the season, the parasites produced from the eggs last deposited had been more delayed in their growth, a high temperature being as necessary to the development of them as to that of the young bee.

From the circumstance that each parasite was attached to the surface of the bee, and fed upon it from without, like the larva of *Monodontomerus*, it was evident that the female does not insinuate her eggs into the body of the bee, but merely attaches them to its skin; while from the circumstance of nearly the whole of the females I had confined in the tube having escaped by insinuating themselves between the sides of the cork and the glass, and forcing their way through chinks which appeared much too small to admit of their passage, there seems reason to think that the usual habit of this species may be to penetrate into the cell of *Anthophora* after it has been closed, and deposit her eggs on the nearly full-grown inmate. This supposition is further countenanced by the acute and denticulated form of the mandibles of the female, and by the absence of an exserted ovipositor, which structure would perhaps be necessary under other circumstances. Further, also, that the bee is infested not by a few, but by an abundance,—a whole brood of these creatures,—which entirely destroy it.

I have allowed my bee-larva, with its parasites, to remain in a cold room up to the present time, but the latter have scarcely at all increased in size, and yet they remain firmly attached to their victim, appearing scarcely even to vegetate.

This is precisely the condition in which the bee itself remains during winter; both that and its parasites requiring a high temperature of the sand-bank, heated by the sun's rays, for their evolution.

DESCRIPTION OF THE FIGURES.

Tab. VIII.

Fig. 4. *Anthophorabia fasciata*, male:—magnified.
- *a.* The antenna of the male.
- *b.* Posterior leg.
- *c.* Inferior surface of the middle leg.

Fig. 5. *A. fasciata*, female:—magnified.
- *a.* The same, with the wings expanded.
- *b.* The antenna.
- *c.* The mandible.
- *d.* Posterior leg.

Fig. 6. The pupa, or nymph.

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X. *The Anatomy and Development of certain* Chalcididæ *and* Ichneumonidæ. *By* GEORGE NEWPORT, *Esq., F.R.S., F.L.S. &c.*

PART III. ICHNEUMONIDÆ (continued).

Read June 5, 1849.

ICHNEUMON ATROPOS, Curtis.

SEVERAL years ago, chiefly in the year 1829, I obtained many specimens of *Ichneumon Atropos* (fig. 1. TAB. IX.), both in the larva and perfect states, in the neighbourhood of Canterbury, but I have not yet met with it in any other locality, nor since the year 1834*. Mr. Curtis, to whom we are indebted for the description, and an admirable figure of the species†, states it to have been bred by Miss Giraud at Faversham, from the larva of *Acherontia Atropos*; that the perfect insect, from which his drawing was made, was taken at Rochester by Professor Henslow; and that another specimen had been taken at Darent Wood by Mr. Davis, so that the insect appears to be a truly Kentish species. It was by no means uncommon in the neighbourhood of young ash plantations, at Canterbury, in the month of July, at the period I have referred to, when I took it on the wing; and I have several times reared it from the pupa of *Sphinx ligustri*, and very frequently have found the larva within the body of the larva of this Sphinx. It seems in fact to be a parasite common to this Sphinx; much more so perhaps than to *Acherontia Atropos*. Mr. Curtis, when describing the species, suggests that the true Ichneumons "prefer naked caterpillars, and probably puncture them after they have descended into the earth, but before they have changed into chrysalids." But this is not the habit of *Ichneumon Atropos*, as I have often found the Ichneumon-larva (fig. 2 *a*, *b*, *c*) within the body of the Sphinx caterpillar several days before this had acquired its full growth, or had ceased to feed, and consequently long before it would have entered the earth to change to a pupa. I suspect that the egg of the Ichneumon is deposited quickly after the caterpillar has changed its skin, and has entered its last period of growth; since, at about the middle of that period, I have found the parasite within it more than a quarter of an inch in length; and consequently, it must then be at least two or three days old. This length of time, added to a similar period, which we may suppose to be necessary for the hatching of the egg after deposition, will bring us to the commencement of the last stage of the caterpillar, when its tegument is soft and pierced with least difficulty. I am not aware whether the Ichneumon-egg is deposited on the surface of the skin through which the larva eats its way into the body, when hatched, like the larva of *Stylops*, or whether, as seems to be most probable, the egg is plunged at once into the caterpillar. The latter opinion seems to be

* Since this paper was read, I have obtained two specimens of the imago from pupæ of *Sphinx ligustri* during the past summer, 1852.

† British Entomology, vol. v. p. 234.

supported by the fact that I have never yet met with even the youngest larvæ between the skin and muscles of the caterpillar, but always internal to the muscles, imbedded in the so-called fatty tissue, between them and the alimentary canal, and always on the dorsal surface, and usually with its head in the direction of that of the caterpillar. I have found it in different stages of growth, from one-fourth to three-eighths of an inch in length (*a*), as early as the middle of August, when it is of a light pea-green colour; but I have obtained full-grown specimens (*c*, *d*) only from the pupa of the Sphinx, sometimes as early as the end of October, but more frequently not until the commencement of March, and sometimes as late as the end of April. Usually, one egg only is deposited in each caterpillar, but sometimes there are two, and both become hatched, although of the parasites one only arrives at maturity, as one is invariably destroyed by the other. I have the following entry of a fact of this kind in my note-book with the date "March 13, 1832," which shows that two larvæ may exist in the pupa of the Sphinx up to a late period, but that one is then destroyed. "The pupa now examined was one in which *Ichneumon Atropos* had deposited two eggs. Two larvæ had been hatched, and these were located in the lower part of the abdomen of the pupa. One of them was very small, being scarcely more than one-fourth of an inch in length, and appeared to have been dead for some time. The other was a fat well-fed specimen, about three-quarters of an inch in length and one-sixth in diameter. It seemed to have destroyed part of the fatty sacculi of the Sphinx, and was lying in the cavity of the body, but it had not injured the upper part of the digestive apparatus, the stomach, behind which it lay so imbedded that I had almost mistaken it at first for the intestine and colon, which had not undergone their proper change. The nervous system of the pupa had not been injured by the larvæ, although its changes had been retarded. It thus appears that the Ichneumon sometimes deposits more than one egg in the body of the caterpillar, as several times before this I have found two of these larvæ in the same insect, although, I believe, never more than one of them comes to perfection." All my subsequent observations have confirmed this conclusion.

The usual situation of the parasite in the Sphinx-pupa is in the tissue of the middle part of the body beneath the dorsal vessel and above the stomach, on which it often rests. This is the position of the full-fed larva in the drawing and preparation (fig. 3), and this is the specimen alluded to and partly described in my second memoir on *Meloë*, printed in the Society's Transactions, vol. xx. p. 335. It was obtained at almost the latest period of the larva state, on the 18th of April, 1832. The other specimens exhibited were procured between that period and the month of October, so that the insect continues to subsist on the Sphinx, and probably passes into a state of hybernation with it, during the long interval of six months. One specimen found on the 20th of March, and removed from the body of the pupa into water, lived several days, while another, not placed in water, spun a few delicate threads to prepare for its change to a nymph. This change usually takes place in April, but when placed in water at that period it soon perishes, as its respiration has then become more active, as the following entry from my note-book shows:—"April 21, 1832. On dissecting a male pupa of *Sphinx ligustri*, a few days ago, I found, somewhat to my mortification, one of my old friends, the larva of *Ichneumon*. It was a large and full-fed specimen, and laid with its anterior portion in the thorax, and its

posterior in the abdomen of the pupa. I put it by for future examination in a vessel of water, having first made a drawing of it (fig. 2 *d*). The spiracles, on each side of its body, are oval, corneous, and slightly project from the tegument, and are situated one at the anterior part of each segment, a little above the longitudinal trachea, and immediately anterior to the trachea that supplies the dorsal surface of each segment. The whole of the tracheal vessels are distinct and distended with air. On looking at it this morning I found it dead." So that although the parasite may reside for many months bathed by the fluids of the Sphinx, it perishes when a change occurs in the degree of activity of its respiratory functions. The length of time which it remains in the nymph-state is about a month or six weeks at the utmost, as most of the specimens I have bred from the pupa have appeared in June. The perfect insect makes its way out of the dead pupa of the Sphinx by perforating the case with its mandibles, on the dorsal surface, and sometimes, as in the preparation now exhibited, it becomes fixed in the orifice and unable to escape (fig. 4).

The body of the larva (fig. 2 *a* to *d*) is composed of fourteen segments, or, if the pedal process of the last segment be reckoned, of fifteen. It is elongated, somewhat tapering, and curved in its earlier stages of growth; but is thick, fat, and pointed at its anal extremity, when mature. The pedal or terminal portion of the last segment is pointed and projecting, and is opposable to a process from the inferior margin of the thirteenth segment, with which it forms a kind of forceps, or prehensile organ by which the larva may affix itself, and change its position in the body of the Sphinx The lateral margins of all the segments are thinned and project as tubercles. These are well-marked in the pro-, meso-, and metathoracic and pre-abdominal segments, but are most distinctly tubercular from the fifth to the eleventh inclusive. These latter segments have also distinct tubercles or segmental appendages on each side of the ventral surface in the shape of mammæ, and in the position of the false feet of the *Terebrantiate Hymenoptera* to which they may be regarded as analogous, and as subservient to the movements of the larva within the Sphinx. The lateral tubercles of the Ichneumon-larva have already been noticed by naturalists, but I believe this is the first time that ventral tubercles also have been discovered. In the very young larva they are situated nearer to the side of the body than in the full-grown, and become more and more approximated to the median line, as the growth of the larva proceeds, by the greater extent of growth and development of the dorsal than of the ventral portion of the segments; thus beautifully illustrating the corresponding process of growth of the segments, and the approximation of the limbs to the median line of the body, in the *Myriapoda*. But although pedal tubercles exist along the ventral surface of the abdominal segments, the future true legs of the perfect insect are indicated only by six white points on the ventral surface of the thoracic segments, in the precise situation, however, of the tubercles on the abdominal.

The head (fig. 5) and mandibles (*d*) of the larva are strong, corneous and of a yellow colour, with the margins and apices of the mandibles black, curved and sharp-pointed, fitted only for piercing and suction, and not for manducation. The maxillæ (*e*) are three-jointed, with the terminal joint broad, triangular, soft and membranous, the second joint very short, and the basal joint strong and elongated. The labium (*f*) is triangular, with a

slight median ridge, and a narrow membranous border, admirably fitted with the margins of the maxillæ for suction. The strength of the mandibles, and the consolidation of the parietes of the entire head, prove to us that the force necessary to overcome the contractile power of the tissues in the Sphinx, in obtaining nourishment, is by no means inconsiderable; yet this force appears to be little, if at all, under the power of volition, since the Ichneumon-larva, like that of *Paniscus*, exhibits only the very slightest indications of sensation, when touched or pressed. It makes no distinct effort to escape, but merely contracts its body, perhaps simply by reflected action, without any intervention of consciousness. This is precisely the condition, as regards the consensual functions of its nervous system, (fig. 9.) under which we might have expected it to exist. Shut up in the body of another animal, and subjected to the compression of its tissues, the endowment of sensation would only entail on it an amount of suffering proportioned to the degree of its perception. Vegetative, or simple organic life, therefore, is, as yet, sufficient for all the requirements of its existence; although afterwards it is to become endowed, as certain of its consensual organs are developed, with perceptions and instincts the most acute. Thus we find in this larva that organs of vision, totally useless to it in its intra-abdominal abode, do not yet exist; and the place of their future development is scarcely even indicated; while the antennæ, almost equally useless to it in its present condition, exist only in the most rudimentary state, merely as slight horny elevations, on the front of the head, (fig. 5 *a*) on each side of the clypeus (*b*), formed of a series of concentric rings (fig. 6) the centre of which is the apex of the future tactile organ. Into this centre I have succeeded in tracing the termination of the antennal nerve; the optic nerves, for the future eyes, being in their usual situation at the sides of the cerebral ganglia. I have also succeeded in tracing this nerve into the corresponding part in the larva of *Anthophora*, in which the antenna is more developed than in *Ichneumon*, and forms a little cone of concentric rings. In *Monodontomerus* the same part is terminated by a single hair (fig. 7), precisely as hairs and spines originate in the central nuclei of tegumentary cells in the larva of *Meloë*.

I have elsewhere shown* that the form of the digestive apparatus is very similar, at the earliest periods of growth, in all parasitic *Hymenoptera*, whether they are enclosed in the same cell with their victim, as in *Monodontomerus*, whether carried about with it attached to its surface like *Paniscus*, or whether shut up within its body like *Ichneumon*. In each of these instances there is not merely a general similarity in the form of its parts, but there is also a concordance in their function. The intestinal portions continue small and imperfect, and no fæces are passed until the larva has arrived at its maturity. I may now further state that this principle, or law, is not confined to the strictly parasitic, or carnivorous larvæ, but operates, as I believe, among the omnivorous, and certainly among the true pollinivorous. The digestive apparatus in the larva of *Ichneumon* (fig. 8), is a pear-shaped elongated sac (*f*), with only a very short intestine (*g*, *h*, *i*), through which, I have reason to believe, no fæces are passed until the larva has ceased to take food. It differs from the great digestive organ in the Hornet chiefly in its larger diameter as compared with its length. Hence we might expect to find but little variation in its function. In

* Linnean Transactions, vol. xxi. p. 61.

Anthophora, as I ascertained many years ago, the chief portion of the digestive organ is an elongated stomach, and although in this instance a short intestine and colon exist, not an atom of fæces is passed, as I have many times, to my complete satisfaction, proved, until the whole of the food is consumed, and the larva has attained its full size.

IV. Development of the Alimentary Canal and its Appendages.

These remarks on the anatomy and development of parasitic *Hymenoptera*, compared with their economy and instincts, lead us to inquire into the mode in which the alimentary canal in Insects is formed. The first developed portions of the parietes of the body in the embryo are the ventral and lateral divisions of the segments. These are produced before the alimentary canal is commenced, the space between them being occupied by the yolk, which supplies the means of growth to the whole. The lateral portions of the segments grow from below upwards, and their free margins gradually more and more approach each other, until at last they meet along the median line of the dorsal surface of the body. The parts which first meet are those of the cephalic, and afterwards those of the anal segments, and the junction of the remaining segments then proceeds in gradual succession from behind forwards, as I have witnessed in very numerous observations in the embryo of *Forficula*. The whole of the remains of the yolk, composed entirely of masses of nucleated cells, is thus gradually enclosed within the body, by the successive union along the dorsal surface of the two sides of the segments, from behind forwards, the last portion included being in the prothorax. The fact of the yolk entering the body at this point of the thorax in the *Crustacea* was first pointed out by Rathke. From the remains of the yolk thus included the alimentary canal is entirely formed, the external portion giving origin to muscular tissue and basement membrane, and the internal, besides supplying nutriment for the further development of the embryo, becoming organized into an elaborating tissue, which for a time retains the general character of the original cell-masses of the yolk, as shown in *Monodontomerus*. The termination of the future alimentary canal is thus the result of a folding on itself of the first portion of the yolk included by the completion of the anal and penultimate segments, and is the commencement, posteriorly, of the column of cells which, becoming perforated, constitute the future colon and small intestine, and which retain the cellæform structure to so late a period in some larvæ, as in the instance we have seen in *Monodontomerus*. In this way, formed from the included yolk, the digestive apparatus becomes a hollow cavity, closed, at first, at its abdominal end by the approximation of the whole of its component structure, but communicating anteriorly with a canal which is formed between the parts of the future mouth, and which becomes its inlet or œsophagus, the connexion of the yolk with the dorsal surface of the body in the prothorax being entirely obliterated. As the growth of the body proceeds, the walls of the alimentary canal become thinner, lose much of their cellæform condition, and acquire a more organized structure. The column of cells which connect the great digestive cavity with the anal segment, as in *Monodontomerus*, are gradually transformed into muscular tissue, from without inwards, and constitute the future intestine, or colon and ilium. These parts being chiefly for the transit of the fæces, and further elaboration of the contents of the stomach, are later developed, but acquire a

more muscular structure than the great digestive cavity, which longer retains its cellæform condition, its lining cells becoming changed into secreting or glandular structures, of two kinds; one of which elaborates the juices required for digestion of food, while others take up the results and diffuse them through the body for the general purposes of nutrition.

Hence we find that the general form of the great digestive cavity is very similar in all embryos of a given class, at the earliest periods; and similar in all which pursue a like habit of life, as in Hymenopterous parasites; the chief structural differences being in those parts which become small intestine and colon. Different species, even among the parasites, differ slightly in regard to these parts, both as to form and as to period of completion. In *Monodontomerus* we have found that the whole of the digestive canal long retains its cellæform condition, its muscular tissue being completed very late. In *Ichneumon* (fig. 8), and *Microgaster* (fig. 11), which feed within the body of their victims, the intestinal portion (*g*, *h*, *i*) of the digestive apparatus is completed more early, and a canal, paved with epithelium, is formed in it, but continues almost completely closed, and does not admit into it a particle of the matter to be rejected until the growth of the parasite is complete. In *Microgaster* the small intestine (*g*) and colon (*h*) are ready to convey the fæces more early than in *Ichneumon*; and this seems to have some reference to the special requirements of this species for a more early rejection of the waste of nutrition. In like manner the more or less early completion of the *appendages* of the digestive apparatus in the advanced growth of the embryo, or of the larva, immediately precedes the unfolding of some speciality of function or of instinct. I have already shown, in the first part of this paper, that the earliest completed glandular organs connected with the digestive apparatus in the larva of *Monodontomerus*, are the *salivary*. So we find also in *Microgaster* (fig. 11), in which they are not only early, but most extensively developed (*d*), for the production of that abundance of silk which is formed by this larva in the construction of its cocoon quickly after it has issued from the body of the insect it has devoured. In *Ichneumon Atropos* also, I have found the salivary organs (*d*) extensively developed in the larva at an early period, doubtless for a similar purpose. Dufour was unable to detect these organs in the perfect *Ichneumon*, although he correctly believes in their existence. The Malpighian structures (*k*), attached to the commencement of the intestinal portion of the digestive apparatus, and the function of which is still a question with some physiologists, although usually believed to be that of the liver, are completed, as we might fairly have anticipated, at a much later period in these parasites than in the vegetable-feeding larvæ, in which the food requires greater elaboration to assimilate it with the animal tissues, than in the carnivorous feeder, which imbibes the ready-formed animal juices of another body. In *Monodontomerus*, the Malpighian organs, even at the close of the feeding period, still exhibit evidences of their original mode of formation by the longitudinal junction and coalescence of cells to form tubes; while in *Ichneumon* and *Microgaster* these parts are more early and more extensively developed, although even in them they are incomplete. On the contrary, in the true vegetable-feeding larvæ, the herbivorous caterpillars, these organs exist well-formed almost from the period at which the insect leaves the egg and begins to feed; and, in many instances, have their secretory capacity increased by the deve-

lopment of cæca over their whole surface, from their opening into the alimentary canal to their distal terminations, which, in all insects, are cæcal, and do not, in any way, anastomose with any other structure; as some have erroneously supposed them to do with the so-called *adipose*, or splanchnic tissue.

Thus we find that in proportion to the more or less early development of any structure or organ, the function or instinct associated with that organ is more or less early evolved; and that in proportion to the completeness of a tissue, such is the degree or perfection of each special function or instinct in the animal.

Additional Note.

Read February 15, 1853.

The change of form and condition which the alimentary canal undergoes, after the parasite has ceased to feed (fig. 8) and is assuming its imago state (fig. 10), is as remarkable as that which takes place in the vegetable-feeding caterpillar, in changing to the chrysalis of the future butterfly or moth. The short narrow œsophagus (*e*) becomes considerably elongated, and instead of terminating, as in the larva, in the third or meso-thoracic segment, it is extended, in the imago, through the meta-thoracic, into the abdominal region. In the anterior portion of the abdomen, the fifth, sixth and seventh segments, it is then dilated into a conical-shaped crop (*f*), which, by a constriction at its termination, and a reflexion inwards of its tissues to form the cardiac valve, is separated from the true digestive cavity, the stomach. This portion of the canal, the chylific ventricle (*f,f*), which occupied nearly the whole interior of the body of the larva, is now restricted to the eighth, ninth and tenth segments. It is a powerful muscular structure, of a somewhat elongated oval shape, and the length of which is scarcely more than thrice its diameter. Around its termination are inserted, externally, the hepatic or Malpighian organs, from twenty to thirty in number (*k*), where, internally, by a reflexion of the tissues, is formed a second valve, the pylorus. The canal then becomes narrowed into what may be regarded as duodenum and ilium, or small intestine (*g*). Beyond this it is again dilated into a more muscular structure (*h*, *i*), the colon or rectum, which is usually filled with *ejecta*, and terminates at the anal valve.

The canal in the imago, as in the larva, is formed of distinct layers or tissues, a *muscular*, a *glandular*, and a *mucous*; and is invested, externally, by a distinct, transparent, *peritoneal membrane*, which appears to be homologous with the peritoneal covering of the viscera in the Vertebrata, and processes, or reflexions of which, in these Invertebrata, clothe every internal organ, the salivary and hepatic glands, the organs of circulation and reproduction, and the adipose tissue, and tracheæ; as expressly mentioned, in regard to the latter, in my article 'INSECTA*.'

The tissues of the alimentary canal are, however, much changed in condition in the imago, from that in which they exist in the larva,—a change which is accompanied by some alteration of function in the entire organ. In the *larva*, in which the canal is little more than a capacious bag, the external or *muscular tissue* is imperfect, and consists of

* Cyclopædia of Anatomy and Physiology, vol. ii. part 18, p. 965 (Oct. 1839).

only a very few longitudinal and transverse fibres, which are separated by wide interspaces (fig. 12 *a*); the one extending throughout the whole length of the organ, and the other encircling every part of it; and these are crossed obliquely by a few fibres which attach the canals loosely to the tegument, and aid its peristaltic movements. But the *glandular* or middle tissue is more complete. It is composed of the cells before alluded to*, which are large, hexagonal in shape, and, in most instances, correspond to the interspaces formed by the decussation of the muscular fibres (*b*). Each cell in its interior has a very large granular nucleus. The *mucous*, or lining tissue of the canal, is formed by a layer of somewhat flattened cells, which have small granulated nuclei, are loosely aggregated together, and have all the characters of epithelial cells (*c*). In the *imago*, however, the *muscular* tissue is composed of very strong longitudinal and transverse bands, crossed as in the larva by a few delicate oblique ones; while the *glandular* tissue is less marked, the *mucous tissue* being most developed; thus, preceding in its changed condition, the change of food of the perfect insect.

Every part of the canal is supplied with tracheæ, the trunks of which, one in each segment, passing transversely inwards, divide into branches, which, again subdivided, penetrate into and ramify through the structure. These, like all other tracheæ, are formed, as described by Sprengel, of three tissues, an external *membranous*, and an internal *mucous*, which enclose between them a strong spiral fibre. The external, as I formerly showed†, so loosely invests the middle, or spiral, that, usually, there is some interspace between them; and, as also mentioned‡, this external tissue is simply a reflexion and extension of the common peritoneal membrane. The ramifications of tracheæ which penetrate the structure of the canal, or of any other organ, become, as I have since found, denuded of this covering as they enter, and then seem to be formed only of two tissues, the spiral and mucous,—if, indeed, there be not also, as I have reason to think there is, an extremely delicate serous, or basement membrane, closely adherent to, and uniting the coils of fibrous tissue, on its external surface. The tracheæ which penetrate the muscular layer of the canal terminate in the glandular or adipose layer, where a few of the branches anastomose; but, as elsewhere stated§, "they do not ramify in the internal or mucous membrane." The *ultimate divisions* of these tracheæ are always distributed separately, and *do not anastomose*. They end in extremely minute, filiform, blind extremities, as noticed by my friend Mr. Bowerbank, F.R.S. This I find is their condition in all structures, in the nervous and tegumentary equally as in the glandular and muscular.

These facts may, perhaps, assist us to understand the nature of the injection of the tracheæ by M. Blanchard‖, and also the mode of nutrition in insects;—the ultimate branches of tracheæ in the tissues of the alimentary canal operating, possibly, as absorbent structures, and inducing the chylific fluid elaborated around them to flow, in its transit outwards, along the channels formed by their loose peritoneal covering, into the regular circulatory currents¶,—a view which, in part,—so far as refers to the presumed absorbent operation of the tracheæ,—was long ago held by Dr. Kidd, in his paper on the Anatomy

* P. 89.

† On the Respiration of Insects, Phil. Trans. 1836, p. 530. pl. 36. fig. 1.

‡ Article 'Insecta,' *loc. cit.* p. 965.

§ *Loc. cit.* Phil. Trans. 1836, p. 532 and 564, pl. 36, fig. 4.

‖ Annales des Sciences Nat. 3me Série, tom. xi. p. 372, *et seq.*

¶ Article 'Insecta,' p. 979.

of the Mole Cricket*; although the precise structure and mode of termination of the tracheæ now described appear to have been unknown to him. Further, they may assist to explain the mode of coloration of the tracheæ in the experiments of MM. Alessandrini and Bassi†, and M. Blanchard‡, and also in others, yet unpublished, by myself, made on the larvæ of *Clissocampa Neustria*, in July 1837.

EXPLANATION OF THE PLATE.

Tab. IX.

Fig. 1. *Ichneumon Atropos*, imago state.

Fig. 2. *a*, *b*, *c*, *d*, larvæ of Ichneumon in various stages of growth.

Fig. 3. Full-grown larva (*a*) between the adipose tissue (*b*) and stomach (*c*) of a pupa of *Sphinx ligustri*. (*d*) brain; (*e*) muscles of the thorax; (*f*) heart; (*g*) testes.

Fig. 4. Perfect Ichneumon escaping through the back of a destroyed pupa.

Fig. 5. Upper and under surface of the head of the larva. (*a*) antenna; (*b*) face or clypeus; (*c*) labrum; (*d*) mandible; (*e*) maxilla; (*f*) labium.

Fig. 6. Magnified view of antenna of larva of Ichneumon.

Fig. 7. Antenna of larva of *Monodontomerus*.

Fig. 8. Alimentary canal, &c. of larva Ichneumon. (*a*) antenna; (*b*) brain; (*c*) optic nerves; (*d*) salivary glands; (*e*) œsophagus; (*f*) stomach; (*g*) intestine; (*h*, *i*) colon and rectum; (*k*) Malpighian organs.

Fig. 9. Nervous system of the larva.

Fig. 10. The imago *Ichneumon* dissected; letters as before.

Fig. 11. Alimentary canal and appendages of *Microgaster*.

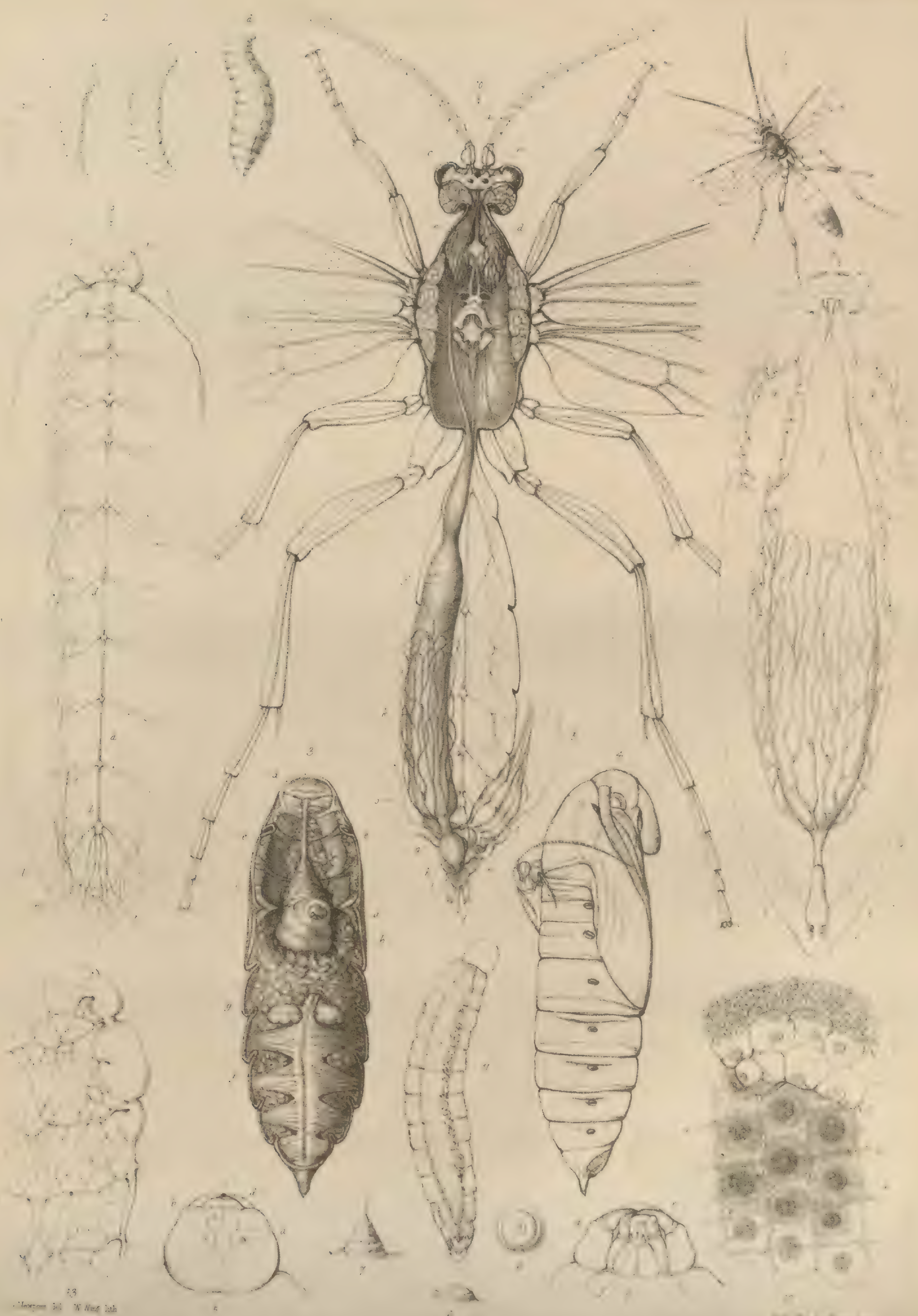
Fig. 12. Tissues of the alimentary canal in the larva Ichneumon. (*a*) muscular layer or tissue; (*b*) glandular; (*c*) mucous.

Fig. 13. Respiratory system in the abdomen of perfect Ichneumon.

* Phil. Trans. 1826, p. 235.

† Gazette Médicale de Milan, t. vi. and Annales des Sciences Nat. 3me Série, tom. xv.

‡ *Loc. cit.* tom. xv.



XI. *Further Observations on the Habits of* Monodontomerus; *with some Account of a new* Acarus (Heteropus ventricosus), *a Parasite in the Nests of* Anthophora retusa. *By* George Newport, *Esq., F.R.S., F.L.S. &c.*

Read March 5, 1850.

As some of the details of a paper on "certain *Chalcididæ* and *Ichneumonidæ*," which I had the honour of communicating to the Linnean Society, in March 1849, drew forth, at that time, the criticism and dissent of some entomologists who had paid considerable attention to those groups, I was desirous, during the past summer, of repeating my observations, and, having the ascertainment of strict truth for my object, sought to correct, if erroneous, whatever might have been questioned, and to confirm by further observations what I had already correctly stated. Accordingly, on the 16th of September last, I revisited the spot at Gravesend, where, two years before, I discovered the larvæ which proved to be those of *Monodontomerus*, and of which an account was given in the paper above referred to.

On this second occasion I had the good fortune to obtain an abundance of these larvæ. Some idea may be formed of the number discovered by the fact that I brought away with me *two hundred and forty-seven* specimens, independent of many that were accidentally lost in the search. These larvæ were found, as on the previous occasion, in the closed cells of *Anthophora retusa*, either in those which still contained the *larva* (Tab. X. fig. 1) or *nymph* (fig. 2) of that bee, or in others in which the original inmate had been destroyed. The number of larvæ of *Monodontomerus* found in the first five cells opened was *nineteen* in the first; *twenty-three* in the second; *thirteen* in the third; *nineteen* in the fourth, and *thirty-four* in the fifth. In each of these cells I had full proof that the parasites had fed on the *Anthophora* itself, as stated by another observer in correction of my first supposition, and as I had already been convinced by examination of the organs of nutrition. The emptied and dried-up tegument alone was all that remained of the body of the original inhabitant in each cell. In order however that there should be no mistake on this fact, I removed three of the cells, which contained larvæ of *Monodontomeri*, without opening them further than to ascertain the presence of the parasites, and placed each in a separate small box to examine the contents at leisure, and more accurately than I could do on the spot. This examination was made on the following day, and each cell was then found to contain the dried-up remains of a single larva of *Anthophora*, with a variable number of the larvæ of *Monodontomerus*,—*nineteen* in the first cell, *twenty-three* in the second, and *thirteen* in the third as just stated. In neither of these instances had the parasites been contained or fed within the body of the bee-larva, but had exhausted it from without, and had drained the body of its contents in the same way as the larva of *Paniscus* drains that of the body of the caterpillar. In those cells in which the parasites were of largest size, the remains of the bee-larvæ had been most completely exhausted; while in two of the cells the tegument was still soft, and not quite emptied, but in each

instance it was shrivelled up and lay at the larger end of the cell. In a fourth cell, which I took home with me almost entire, there were eighteen larvæ of *Monodontomerus*, and the remains of a *nymph* of *Anthophora*. In this cell the parasites were scarcely more than one-half grown, and the remains of the nymph were very complete. The head, limbs, and parts of the mouth were still uninjured, but the thorax and abdomen were nearly emptied. The parasites had pierced the body in both these regions, and were ranged on each side of it. This specimen therefore confirmed Mr. Smith's statement*, that the *Monodontomeri* feed on the nymph of the bee, as I had previously shown that they feed on the larva. It also afforded the fullest confirmation of my original opinion,—that these parasites are *external feeders*,—a view to which I was led,—*not*, as erroneously stated by Mr. Westwood, in the printed Proceedings of the Society†, from the simple fact of my having found that the bodies of these parasites have an armature of hairs; *but*, as explicitly stated in my paper‡, as read to this Society, because I have never yet found hairs on the bodies of internal feeding parasites. External feeders, nevertheless, may be deficient of this armature, as in the instance of *Eulophus Nemati* cited by this observer.

As the whole of the tegumentary portion of the body of the nymph of *Anthophora*, obtained by myself, like that of the larva, remained in the cell, although partially shrivelled up, there seems to have been some error also, in part of Mr. Smith's observations, as given in the following words§: "When first observed the pupa of the bee was about one-third consumed, and at last *not a vestige of it remained*; all that the cell contained, besides the larvæ, being a small portion of yellow dust, or small granules." I cannot help regarding this statement as having originated in oversight or mistake, as in every cell which I have examined the tegumentary remains of the destroyed bee-larva have invariably been present; while in neither of the many cells which I opened very carefully at the moment of finding them in their natural haunts, nor in the four which I preserved for still closer examination at home, could I detect any "yellow dust or granules." There were only the parasites and the more or less dried-up tegumentary remains of the destroyed insect. Neither was there any "yellow dust or granules" in the cell with the nymph of *Anthophora*. All which this contained were the parasites and the remains of the nymph; together with the larva skin it had thrown off on assuming this condition; while the larger end of the cell was coated with a perfectly smooth layer of *ejecta*; a coating which, as I formerly stated, it always gains after the larva has ceased to feed, and before it changes to a nymph. I mention these circumstances the more particularly, because, as Mr. Smith's remarks on *Monodontomerus* were communicated to the Linnean Society in correction of mine on this insect, previously read, and as the abstract of that paper has since been published in the "Proceedings," it is incumbent on me to notice his statements with care, and to show in what we agree or differ. In his communication to the Society, he states that he obtained the larvæ of this insect "in the summer of 1848‖," and also remarks:—"I then made a drawing of the larva of the parasite, which I enclose." On this drawing is written the following confirmatory note:—"Larva found feeding on the pupa of *Anthophora retusa*, *July* 1848." The following

* Proceedings, vol. ii. p. 29, April 3, 1849. † May 1, 1849, vol. ii. p. 37. ‡ Transactions, vol. xxi. p. 67.

§ Proceedings, vol. ii. p. 29, April 3, 1849. ‖ *Loc. cit.* p. 29; also Ann. and Mag. Nat. Hist. August 1849, p. 124.

passage from the Proceedings of the Entomological Society*, printed in 1848, records the exhibition, by myself, at that time, of specimens of the *Imago* insect, reared from the larvæ mentioned at p. 67, found on the 12th of September, 1847:—"July 3rd, 1848. Mr. Newport exhibited a new species of the genus *Monodontomerus*, belonging to the family of the *Chalcididæ*, reared from larvæ which he had found in the nests of *Anthophora retusa*. He proposed for it the name of *M. nitidus*."

Thus my recent observations on *Monodontomerus* in its natural haunts, supported by further examination of the anatomy of its digestive organs (figs. 3 & 4), have fully confirmed my former opinions as regards the nature of the larva, that it is an *external* and not an *internal* feeding parasite, and that some remains of the destroyed bee-larva are always found in the cell. They confirm too the observation that the bee-nymph is preyed upon; as well as that the larva of *Monodontomerus* is carnivorous; but they do not support the statement, and the inference to be deduced from it, that "not a vestige" of the bee is left in the cell. Further, they give strength to the opinion I have advanced respecting the mode and time of introduction of the eggs of the parasite; viz. by perforation of the cell. The circumstance of the bee-nymph being preyed upon, as well as the larva, goes far to establish this, as in each instance the parasites with the nymph were scarcely more than one-half grown. This seems to show that they had been introduced at the time of change, or at a very late period of the larva state. There seems reason to believe also that the eggs are seldom conveyed into the cell until long after this has been closed, and consequently when the bee-larva within has far advanced in growth, as in no one instance could I discover a particle of the food of the larva.

Being desirous, however, of ascertaining facts by direct observation, rather than of arriving at views by inference, I placed, on the 17th of September, twenty of the most healthy middle-sized specimens of the larval *Monodontomeri* with a single larva of *Anthophora*, in one division of a glass tube; and twenty smaller specimens, with a nymph of this bee, in another division of the same tube, separating the two sets with a piece of sponge, and closing the tube with a cork. On the following day the parasites had arranged themselves with their heads towards the body of the larva, but they did not appear to have commenced their attack, probably from a cause which I shall presently mention. On the next day, however, the third of inclusion in the tube, I saw one individual attack the nymph, and in precisely the same way in which the larva of *Paniscus* attacks the caterpillar, by piercing the skin, and imbibing the fluid as it transudes. On the 22nd of September, the fifth day of inclusion, I was surprised to find that some of the specimens were changing colour, and looking unhealthy, and that not one of them appeared to be feeding. On the following day the whole were slightly discoloured; and, on very close inspection, I then first noticed that their bodies were covered with multitudes of little spherical bladder-like objects, exactly similar, at first view, to microscopic drops of fluid transuded through punctures in the skin. My hope to follow out a series of observations on these larvæ was now at an end, as it was evident to me that they were diseased and perishing. But I was entirely at a loss to imagine the cause of this failure, as at the time the specimens were collected, the whole were perfectly healthy and strong. On the 24th September they were

* Trans. Entomological Society, vol. v. part 5, 1848, p. 42.

still further discoloured, and many of them were dead, and all were covered with the bladder-like bodies in greater abundance.

On examining other specimens of these larvæ, which I had placed in separate bee-cells, I found that these also were in a similar condition; and on inspecting my collection of larvæ and pupæ of *Anthophora*, these too, to my utter astonishment, were covered in the same manner. I noticed also that the vesicles first observed on the larvæ in the glass tube had become much larger, during the past two days; and on inspecting them very carefully with a lens, I found that the bladder-like bodies were either the nidi of parasites, or living parasites themselves attacking and exhausting the enemies of the young bee, as the bee had been attacked by them (fig. 5). Thus in less than eight days from the time when my specimens were collected, the whole were irretrievably destroyed by objects which now covered them in multitudes, but which at first were so microscopic as entirely to escape observation. As it was now evident that my whole collection of larvæ of *Monodontomeri* would soon entirely disappear, I placed a number of them, together with the parasites that covered them, in spirit for future examination. Out of nearly two hundred and fifty specimens of these, and of a still greater number of larvæ and nymphs of *Anthophora*, the result of the persevering labour of several hours' search, I was not able to save even a single specimen. Wherever I placed them in the room appropriated to my investigations, they became covered with these microscopic enemies, whether secured in wooden or tin boxes, or covered earthen pots. I now began to suspect the cause of this mischief. During the time I was collecting the larvæ, on the 16th of the month, I found some bee-cells nearly filled with a large mass of vesicle-like bodies. These were completely new to me. The body of the bee-larva seemed to have been changed into this mass of spherical nondescripts (fig. 1), which, although quite distinct from each other, were aggregated together, and somewhat resembled a microscopic bunch of grapes. Each of the bodies was opake and clouded on its upper surface, and seemed to include other bodies. On its under surface it was clear and transparent. They varied greatly in size, from that of a minute pin's head to nearly one-sixteenth of an inch in diameter. Having found several of the cells filled with them, I collected these cells, for the purpose of ascertaining, if possible, the nature of their contents. I found also one cell in which these bodies, as well as the remains of the bee-larva, were almost dried up. The instant this cell was opened and exposed to light, I noticed, on examining the interior with a lens, that it was partly filled with what looked at first like dust; but more closely observed this was seen to consist of crowds of little brown objects (fig. 6), in a state of the most vivid and incessant motion. These were so exceedingly minute that I could only recognise them to be living creatures by means of the lens, and even then with difficulty, without being able to distinguish their form, as they were of the same colour as the clay-soil of the nest. They reminded me very forcibly, by the vivacity of their movements on exposure to light, of the larvæ of *Meloë*, although scarcely one-third the size of those diminutive creatures when first hatched.

No Pandora's box could ever have been more fatal to man, than this bee-cell and its contents became to my store of larvæ. I placed it together with those which seemed to contain only vesicles in the same case, which I did not again examine until the following day, and then found, to my surprise, that but very few of the dust-like objects remained in

the cell. The majority, as was afterwards proved by what I have just stated, had crept out and distributed themselves over the room. Many probably had escaped into my other collecting boxes while being conveyed home.

It was in the afternoon of the following day that I placed my larvæ of *Monodontomerus* with that of the bee, in the closed glass tube, as already mentioned; so that, in all probability, it was during the few hours that my boxes which contained the young bees and their parasites remained near that which enclosed the cell, that these little creatures escaped and affixed themselves to the larvæ. This was at a stage of existence when the whole brood of nondescripts had been recently matured, and probably soon after there had been communion of their sexes (?) within the cells,—if, indeed, males, which I have not been able to identify, are produced,—and before the bodies of the fertilized females, which the vesicles in the other cells, as well as those afterwards found on my larvæ, all proved to be, had begun to be enlarged. These diminutive objects I soon found to be *Acari* of a new type (fig. 7).

I have said that the bladder-like bodies were fertilized females. There seems to be full proof of this in the following circumstances. At the time when I enclosed the larval *Monodontomeri* in the glass tube, the temperature of the atmosphere of the room was above 55° Fahr., and very frequently during the ensuing fortnight was more than 60° Fahr. The growth of the *Acari* was then very rapid. Within ten days from the time when they affixed themselves, indeed within eight from my first observing them, the bodies of some were enlarged to the size of the head of a small pin, and the ova within them were readily and distinctly identified with the microscope. They increased in bulk most rapidly during the first fortnight, after which their enlargement was less perceptible. On the contrary, I fancied, but was not certain, that they became somewhat smaller. Several of them at first were more opake, and afterwards became of a brownish colour. In about three weeks, during which time the tube had been frequently exposed to the sun, there was full proof that some of these specimens had produced young. The interior of one end of the tube was then covered with a great number of *Acari*, such as I had originally seen in the bees' nest (fig. 6); not with the abdominal portion of their bodies enlarged, but short, narrow, and somewhat tapering at its extremity. These little beings appeared to have only recently come forth, as they were of a much lighter colour, and somewhat smaller than those which were found in the cell. Some of them placed on a micrometer plate measured only sixteen thousandths of an inch in length. The glass tube being tightly stoppered with a cork, so that nothing could enter or escape, it was fair to conclude that these were the young of some of the females attached to the bodies of the larvæ, although I neither saw them come from their parents, nor was able to find that any ova had been deposited from which they might have been hatched. Nevertheless they had already undergone the change common to the tribe, —that of obtaining an additional pair of legs, as they had the full complement—four pairs. It is well known that this is not the condition in which *Acari* are usually produced, each having at first but three pairs. It remains for future inquiry, therefore, to show in what condition this species first makes its appearance,—whether ova are at any time deposited and afterwards become hatched, whether ova are produced at one season and living young at another, or whether, as I have most reason to conclude, the

species is viviparous. The females, already fertile when they quit the cell, move at first with great celerity, the abdomen being then the smallest portion of the body. But as soon as they have penetrated into other bee-nests, and affixed themselves to the bodies of the inmates, and begun to drain them of their fluids, the posterior three or four segments of the bodies of the little nondescripts become rapidly more and more enlarged, and assume the spherical bladder-like appearance seen on the bee-larva or its parasite. This enlargement is carried to such an extent, that this portion of the body of the gravid *Acarus* soon becomes at least ten, or twenty, or even more times its original size, and at first sight seems alone to constitute the entire being (fig. 8). The *Acarus* in the meantime loses its power of locomotion, and becomes affixed to one spot, or changes its place so little, and so imperceptibly, as to appear to be immoveable. Gorged with the nutriment imbibed, it sinks into a state of almost vegetative existence, and seems to lose all the energy and power of motion it originally possessed; strongly reminding us of a similar degradation of animal function which the active little *Meloë* undergoes before it attains its full growth as a larva; and which the *Stylops* also passes through, before it is re-developed in the one sex as one of the most lively of beings, or diverges still further in the other, from the usual condition of an animal, as a mere nidus for the production of new existences. This approach to the vegetative type is the form in which these pregnant *Acari* are found in the bees' nest, crowding over, and hiding the remains of the larva they have destroyed. From all which I have as yet been able to observe, these *Acari* appear to become nidi for the development of the eggs formed within them; and I have much reason to believe that, as in *Stylops*, the young pass through their earlier stages within the bodies of their parents, and escape from them in an active condition, possibly at first as hexapods. The common cheese mite, according to Lyonnet, produces living young at some temperatures, and ova at other more reduced ones; and this, as we know, is the case with the whole tribe of *Aphides* among insects. Whether the female *Acari* perish before their young are hatched, or whether, as I believe, the birth of these is the immediate prelude to their parents' death, I have not yet ascertained. It is certain, however, that the largest-sized females become discoloured earlier than the smaller, and this too I believe in proportion to the temperature of the season. The temperature of the season, or of the locality in which the *Acari* are placed, greatly influences, not only the more or less rapid enlargement of the bodies of the females themselves, but, as I believe, the hatching of the ova within them. This has been proved to me by the fact that a very large proportion of the females, with the abdomen of full size, early in the autumn, but when the temperature of the season was gradually subsiding,—and which I was careful not to expose to the sun,—have remained alive during the winter to the present time, a period of five months, without producing young, or, so far as I can discover, depositing any eggs. In some of these specimens which I examined a few days ago, I found the ova still immature, and even the germinal vesicles within them still present, and easily detected. We may conclude, therefore, that a rather high temperature is required to complete the development of the ova and produce the embryo. This high temperature is always found during summer in the natural haunts of the *Anthophora*. The clay banks in which these insects construct their cells become heated by exposure to the morning and

mid-day sun, sometimes to as much as 84° Fahr. at a depth of one inch and a half, as I have elsewhere shown*, and much of this heat is retained throughout the whole twenty-four hours; so that, in all probability, the growth of the pregnant *Acari*, and the hatching of their ova, then proceed very rapidly; while, on the contrary, these, as well as the changes of the bee-larvæ, are entirely arrested during winter. This will explain, what might otherwise seem to be discrepant, that some young *Acari* were produced after exposure to the sun, and in a warm room in October, while others not exposed to the sun, and the season becoming colder, have remained until the present time undeveloped.

Having stated thus much respecting the economy of this microscopic parasite, I will now endeavour to describe it, and to show that it constitutes a new genus of its class. It belongs to the section *Tyroglyphus* of Latreille and Gervais, the tribe *Sarcoptides* of Koch, which has the *Sarcoptes scabiei* of the human subject as its type, and which includes also the *Demodex folliculorum* of Simon and Owen, a parasite in the follicles of the hairs in Man. It is most nearly allied to Koch's genus *Dermaleichus*, most of the species of which are parasites on birds; but it is perfectly distinct from that, as well as from the genus *Trichodactylus* of Dufour, a parasite on the Mason-bees of the genus *Osmia*. It is equally distinct from the *Ansetus* of Dujardin, which also is a parasite on bees, although it approaches these two genera in certain particulars. It resembles the latter in the general elongated form of body and in the size of the haunches of the legs; but it differs in the body being articulated throughout, in having a somewhat cordiform moveable head, the prothorax distinct from the trunk and abdomen, and the anterior pair of legs palpiform, while the three posterior pairs are equal, and terminated by four-jointed slender tarsi, the last joint in each being cordiform and pad-like, as in the larva of *Stylops*. In this latter respect it has affinity with the genus *Hypopus* of Dugès, as it has also with *Trichodactylus* in the legs being covered with a few very long hairs.

With regard to the change and enlargement of the body in the female sex of the *Acarus*, every one will remember that its parallels are to be found amongst true hexapods, in the *Termites* and the *Pulex penetrans*.

The characters I would assign for the new *Acarus* are:—

Class ACARI.

Fam. SARCOPTIDES, Koch.

Gen. HETEROPUS, Newp.

Corpus elongatum, subarticulatum. *Caput* mobile. *Thorax* a trunco distinctus, ad latera corpusculis clavatis munitus. *Pedes anteriores* palpiformes; *reliqui* (parium trium posteriorum) æquales, arcuati, attenuati, tarsis gracilibus 4-articulatis, articulo terminali lato vesiculari.

H. VENTRICOSUS (figs. 6, 7 & 8), pallidè ferrugineus, capite saturatiore, prothorace paribus 2 pilorum longorum, pedibus subrobustis; articulis omnibus longè pilosis: tibiæ articulo apicali corporis dimidium æquante.—Long. $\frac{1}{6}$—$\frac{1}{8}$ lin.

♀ gravidæ abdomine magnoperè inflato vesiculari.

Hab. in nidis *Anthophoræ retusæ*, apud Gravesend, in comitatu Kent, mense Sept. 1849.

* Phil. Trans. 1837, p. 279.

The importance of a thorough examination of these microscopic pests is at once evident, in the fact that the type of the family to which the whole of them belong is the noisome parasite of the human subject; that another, as yet undetermined form of the same tribe, is thought by some to be connected with one of the most fatal ailments of our frame, dysentery; that two distinct *Sarcoptes* yet undescribed affect the horse and sheep; and that even the common sparrow, and our little pet the canary, are infested by others of this class.

When, therefore, we reflect on the ailments which these produce, and on the diminutive size of the creature I have just characterized, and which in its effects are so destructive to other tribes, and bear in mind that this mere speck, this particle of dust, is organized for all its purposes as completely as the most perfect of any of the whole sub-kingdom to which it belongs,—even to the flexor, the extensor, and the rotator muscles of its truly atomic limbs (fig. 9) and tarsi,—while the entire body of the creature, when first produced, measures scarcely more than sixteen thousandths of an inch in length;—and then call to mind that the mere foot alone of the *Dinornis*, or of the *Palapteryx*, the ancient colossal birds of the Antipodes, measures, as shown by the most renowned anatomist of our age, Professor Owen, more than twelve inches—nearly seven hundred and fifty times the whole size of this little body:—who can but feel astonished at this range of Creation?—who can but feel that the study of natural history,—not as the amusement of an hour, but as a sober contemplation,—must tend to exalt as well as to expand the human intellect; and that the most microscopic atom of organized life, considered as part of the world, is as deserving of our fullest attention as the most gigantic?

DESCRIPTION OF THE PLATE.

Tab. X.

Fig. 1. A cell containing the larva of *Anthophora* attacked by larvæ of *Monodontomerus*. (*a*) natural size; (*b*) magnified two diameters.

Fig. 2. A cell containing the nymph of *Anthophora* attacked by the parasites:—magnified.

Fig. 3. Further details of the anatomy of *Monodontomerus*. Digestive system of the larva. (*a*) salivary organs; (*b*) section of the œsophagus, (*c*) of the stomach, and (*d*) of the pylorus; (*e*) the Malpighian vessels.

Fig. 4. Digestive system of the nymph. (*a*, *b*, *c* & *d*) œsophagus and stomach, as above; (*e*) Malpighian vessels, exhibiting their cellæform structure and mode of termination.

Fig. 5. Larva of *Monodontomerus* attacked by parasitic *Acari*. (*a*) natural size; (*b*) magnified three diameters.

Fig. 6. Newly developed adult *Acarus*, *Heteropus ventricosus*:—magnified.

Fig. 7. Pregnant female *Heteropus ventricosus* during the development of her ova:—magnified.

Fig. 8. Several fully developed *Acari* attached to part of the proboscis of the nymph of *Anthophora*.

Fig. 9. Posterior leg of the *Acarus*:—magnified.

Fig. 10. Magnified view of the head of the male *Anthophorabia fasciata*, Newp., as seen by transmitted light, exhibiting the structure of the antennæ (*a*), showing the flexor (1) and extensor (2) muscles, and (3) the cellæform structure in the cavity of the basilar joint; (*b*) the lateral, and (*c*) the vertical ocelli; (*d*) the brain; (*e*) the labrum; (*f*) the mandibles.

XII. *On the Development of the Spores and Elaters of* Marchantia polymorpha.

By ARTHUR HENFREY, *Esq.*, *F.R.S.*, *F.L.S. &c.*

Read November 20, 1849.

M. MIRBEL*, in the first of his celebrated essays on the structure and development of *Marchantia polymorpha*, expresses himself in a note in the following terms:—"The origin of the elaters would, I think, be a curious discovery. I should not be astonished if most direct and positive observations led one day to the conclusion *that these organs are but one of the numerous modifications which the utricles undergo*. Such a result would decide many questions which we have long been endeavouring to solve."

In his second memoir on the same subject†, he announced the fact that he had observed the development of these bodies from the utricles; and the progress of vegetable anatomy since that time has made it a matter of certainty, that all the forms of the elementary tissues are to be referred to a cellular type. But so far as I can discover, all observers, who have hitherto investigated the development of the spores and elaters of the *Hepaticæ*, have overlooked certain important points. In the course of a series of observations on the development of spores, made in reference to the theories of cell-development in general, my attention was strongly attracted to a very peculiar condition which I met with in the young sporangia of *M. polymorpha*, and as I can find no notice of the phenomena in the works of previous authors, I am induced to publish an account of them.

The spores of *Marchantia* are produced, as is well known, in sporangia enclosed in peculiar receptacles or involucres situated at the base of the rays of the stellate body borne on the pedicel, on the under side. It is unnecessary to notice the characters presented by the envelopes of the sporangia, as these have long since been well described and figured; the whole course of development of these parts is beautifully illustrated in the memoirs of M. Mirbel already referred to.

The first indication of the production of the sporangia is the appearance of the organs called pistillidia, exactly resembling those of the other *Hepaticæ* and of the Mosses. Within the enlarged base of the pistillidium a small globule of a green colour is soon met with; this is the nascent sporangium, and in its subsequent development it enlarges within the expanding cavity of the pistillidium, acquiring a pyriform shape, and exhibiting at one period a little filamentous process at its apex. The nature or import of this process I cannot make out, but I found it also in *Sphærocarpus terrestris*, and it is

* Recherches anatom. et physiol. sur le *Marchantia*, &c., Mém. de l'Acad. Roy. des Sc. de l'Institut de France, vol. xiii. p. 337.

† Complém. des Observ. sur le *Marchantia, &c. loc. cit.* xiii. p. 375.

represented in the figures of most of the *Ricciaceæ* in Lindenberg's Monograph*. While the enlargement of the nascent sporangium tends to fill up the cavity of the pistillidium, the single layer of cells composing the wall of the latter is developed still more rapidly than the sporangium; its elongated neck disappears, and it is found in the nearly ripe fruit as a loose cellular envelope immediately enclosing the sporangium; when quite ripe it bursts above, exhibiting irregular teeth. The envelope of the globular sporangium of *Sphærocarpus terrestris* appears to me identical in its nature, but it remains green and does not burst: a little orifice in the apex, corresponding to the base of the neck-like portion of the pistillidium, may permit the escape of the spores; otherwise they can only become free by the decay of this involucre.

The walls of the sporangia of *Marchantia* are composed of a single layer of cells, at first almost cubical, and filled with chlorophyll-vesicles; but as they enlarge they become elongated in the vertical direction, the chlorophyll disappears, and spiral fibres, or more frequently annular bands, make their appearance upon the walls. These bands are of a flattened riband-like form, and of a yellow colour, the membrane of the walls of the perfect cells is hyaline, and the cavity contains only a few yellow granules. This structure of the wall of the sporangium of annular fibrous cells is analogous to that of the *Jungermanniæ* and to the spiral tissue of anthers, and is for a similar purpose, namely by its elasticity to cause the rupture of the mature parts as they become dried by evaporation.

No similar elastic tissue presents itself in the *Ricciaceæ*, in which moreover the elaters are absent†.

In all the foregoing points, my observations agree perfectly with those of M. Mirbel. Before proceeding to detail what I have seen in the development of the spores, it will be as well to give an account of what had been observed by preceding authors.

Mr. Griffith, in a note appended to M. Mirbel's first memoir‡, stated, with regard to *Targionia hypophylla*, that "in the young ovaries the elaters are not visible, and the seminules, united by a gelatinous substance, form as it were a continuous mass. They then seem to be vesicles filled with corpuscules, although when mature each is evidently a cellular body."

M. Mirbel§ remarks on the same plant:—"The nascent seminules are contained in the cells of a tissue which fills the young ovary; each cell contains three or four seminules. As the ovary advances in age, its internal tissue becomes dislocated, and is broken up into as many distinct utricles as there were cells, so that the little groups of seminules each have a utricle for an envelope.

"The seminules, young or old, are themselves simple utricles, which contain colourless spherules attached to their walls. This observation does not agree with the opinions of Mr. Griffith; according to him, the mature seminules are formed of cellular tissue.

"The elaters do not display themselves until some time after the dislocation of the tissue. They are slender, colourless, perfectly closed tubes, always with blind terminations (*en*

* Lindenberg, Monographie der Riccien, Nov. Act. Acad. Nat. Cur. xviii.

† According to M. Mirbel, the cellular tissue of the sporangium of *Targionia* (which has elaters) is not annulated, but the cells have half-rings on the internal and lateral walls, like the *Jungermanniæ*.

‡ *Loc. cit.* p. 371.

§ *Loc. cit.* p. 371–2.

cæcum), and often curved like a hook. At this epoch they contain colourless spherules which subsequently disappear.

"When the elaters are older they have acquired a yellow colour, and one would say that each served as a sheath to two long, very narrow bands, rolled concurrently and parallel, like a corkscrew, with very loose convolutions. There is an optical illusion here; the bands do really exist; but instead of being free in the interior of the tube, they are an integrant part of it."

In his second memoir*, M. Mirbel gives an account of the development of the elaters of *Marchantia polymorpha*:—"It (the sporangium) is at first merely a mass of tissue, composed of utricles filled with green spherules. But when the pistil had attained the degree of development last indicated, the internal utricles had become detached from one another, while those of the superficies remained closely united, and constituted a balloon-like sac, completely closed, in which the internal utricles were imprisoned. These were not all of one kind; some had been developed into long slender tubes, pointed at both ends, which most certainly still adhered by one of these ends to the internal surface of the sac; the others, in much larger numbers, polyhedral at first, had passed into a spherical form by the gradual rounding off of their angles. To each utricle elongated into a tube, a double series of utricles were feebly adherent. Both kinds were still filled with green spherules.

"As they advanced in age, the utricles composing the sac and those elongated into tubes underwent modifications, to which I must draw the attention of physiologists." [Three or four flattened rings, arranged parallel, appear on the walls of the cells of the sac; these become better defined, and at last acquire a yellow colour. My own observations on this point agree perfectly with those of M. Mirbel.] "The utricles elongated into tubes only differed from the others in form at first; they then possessed a delicate, simple, diaphanous, entire, uncoloured, membranous wall, but they soon became thickened, lost their transparency, and became marked all round, throughout their whole length, with two parallel streaks, closely approximated and describing helices. Then, increasing in size, their streaks became slits which cut the wall of each, from one end to the other, into two filaments, and the convolutions of these filaments separated, resembling the turns of a corkscrew. Finally, the two filaments acquired a rusty yellow colour, and the metamorphosis was so complete, that if I had not followed the modifications, step by step, I should now be afraid to say that these two filaments were at first one simple utricle; but the fact is constant, and I am convinced that whoever repeats the series of my observations, with the firm determination to let nothing escape which it is possible to see, will arrive at the same result as myself."

Bischoff gives no account of the development of the elaters, and evidently mistakes their origin, for he says†:—"Where we find among the spores, elaters *which, arising originally as elongated cells from the internal wall of the sporangium*, lie among the parent-cells of the spores, I should rather compare them to the cellular filaments which occur in the capsules of Mosses, *e. g.* in *Buxbaumia*, *Funaria*, &c., running across between the outer and inner membranes of the sporangium; and in *Polytrichum*, in part

* *Loc. cit.* p. 382.

† Bemerkungen über die Lebermoose; Nova Acta Ac. Nat. Cur. xvii. p. 909 *et seq.*

between the latter and the columella; while in the *Hepaticæ* where the inner membrane is wanting, they run in free among the parent-cells of the spores."

Von Mohl* gives no account of the development of elaters; with regard to certain of his views on the development of the spores, I shall allude to the papers just cited, further on.

Gottsche† does not describe the development of the elaters, nor indeed the earlier conditions of the spores.

I now proceed to the results of my own researches on this subject.

The little green cellular body which is found within the pistillidium increases in size, and in the course of its growth its cells are differently modified; the external layers, over the whole surface, adhere together into a membrane, which becomes the spiral-celled membrane of the capsule; the cells contained within this layer produce the spores and elaters. I have not been able to determine satisfactorily the earliest conditions of the enclosed cells. In the youngest specimens I found it impossible to ascertain the true nature of the structure, on account of its delicacy, but I believe that Bischoff is certainly wrong in supposing the young capsule to be filled with a mucilaginous fluid (*brei*). Mr. Griffith and M. Mirbel state, that there exists a continuous tissue in *Targionia*; and Mr. Fitt‡ states that the apparently gelatinous contents of the capsule of *Sphærocarpus terrestris* exhibited a cellular appearance, when dried up, on the object-glass. From these facts and from analogy, I am inclined to believe that the young capsule is at first formed of a continuous cellular structure, and that the cells of this tissue become parent-cells, producing new cells within them, which they set free by becoming dissolved; exactly as occurs in the production of the parent-cells of the pollen-grains, in the continuous cellular tissue of anthers.

However this may be, it is certain that cells do become free in the cavity, producing the elaters and spores, and the condition and form in which they present themselves is very remarkable. M. Mirbel states that he found minute elongated cells, the young elaters, mingled with small squarish cells, the spores, which afterwards acquired a globular form. It is evident from this that he missed the earlier stages of the metamorphoses. I found the young capsules to contain elongated cells alone, and these of two sizes. The whole cavity of the capsule was filled up by elongated cells arranged side by side, and apparently radiating from the centre; a portion of these elongated cells were narrow, and were interposed between much longer and broader ones of the same form, in such a manner that scarcely any interspaces existed. The narrow cells are the young elaters, while the broader ones are the parent-cells of the spores. The subsequent development I have followed out clearly. The young elaters are elongated, slender tubes, attenuated toward each extremity; they are at first filled merely with an almost colourless, coagulable protoplasm. After a short time starch-granules make their appearance in them, the true

* Ueber die Entwickelung und den Bau der Sporen der Crypt-Gewächse, Flora 1833; Vermischte Schrift. 67. Ueber die Entwick. der Sporen von *Anthoceros lævis*, Linnæa 1839; Verm. Schrift. 84.

† Ueber *Haplomitrium Hookeri*, Nova Acta, vol. xx. Ueber die Fructification der Jungermanniæ Geocalyceæ, Nova Acta, vol. xxi.

‡ London Journal of Botany, vol. vi.

nature of these bodies being readily determined by iodine. The starch-granules frequently lie within the young tube, in such a manner that they may easily be mistaken for the rudiments of the spiral fibres, but they are quite distinct from these, and disappear before the fibres begin to be deposited. I believe that the accounts given by some authors of the formation of spiral fibres in spiral vessels from rows of minute granules are incorrect, and have arisen from observation of starch-granules lying in rows, often running obliquely across the tubes. As the tubes grow they enlarge more in length than in diameter, and appear as very long, slender filaments; the starch-granules, and finally the protoplasm disappear, and faint streaks, denoting the nascent fibres, are at length to be perceived upon the walls. These gradually become more and more distinct, until in the mature elaters they present themselves as strong, flattened bands. In *Marchantia* there are two fibres, and the ends of these are confluent at the extremities of the tubes in which they are contained. More properly speaking, therefore, the fibre is one endless fibre twisted upon itself; the best possible condition of structure for the purpose. We may represent the condition of the fibres by a piece of string doubled, and with its ends tied together; this, when twisted up, unrolls immediately one end is set at liberty; or, if both ends are let loose at once, the whole piece springs away as it unrolls, just as the elaters of *Marchantia* spring out when the capsules burst. In unrolling the fibre it tears up the membrane of the wall of the tube, and when the elaters are examined after they have been discharged, the fibres are found somewhat unrolled, and the torn membrane is often no longer to be detected.

While the elaters are passing through these stages, the larger elongated cells exhibit a very remarkable series of changes, which appear to differ from everything that has yet been observed in analogous structures. They are at first filled, like the elaters, with a delicate, colourless protoplasm, in which float exceedingly minute granules; this substance is coagulated even by water, and still more strongly by alcohol, acids, and iodine. It is apparently the same substance that occurs in all young cells which increase by self-division. I have found it unmixed, as here, in young hairs, in the parent-cells of pollen before the formation of the septa, in the confervoid body which grows out from the embryonal vesicle of the *Orchidaceæ*, in the Yeast Fungus, &c. In most cells it very soon becomes mixed with starch and chlorophyll vesicles.

The elongated cells soon exhibit transverse streaks of a lighter colour, from the protoplasm separating into a number of portions, and cross membranes are produced at these places, dividing the tubular cells into a row of cells, all of square form, except the two end ones, which are attenuated toward the free point, and thus appear triangular in the side view. I could not make out whether the septa were formed by gradual growing in of the membrane; if so, the process must go on very quickly. Neither could I detect a double membrane; but this must exist, as the cells afterwards separate from each other at these points. Vertical septa often occur, producing a double row of cells from the original tube. M. Mirbel appears to have made his earliest observations subsequently to the breaking up of these rows of cells, and thus to have missed them. They are a constant phenomenon, and I know of no analogous structure, unless we compare them with the single rows of cells which first appear in the tissue of the anthers, and by subdivision become the parent-

cells of the pollen; but the cases are very dissimilar, since in *Marchantia* these rows of cells are produced from free tubular cells, in great numbers, after the dislocation of the tissue of the cavity of the sporangium.

About the time the cells separate from each other, the contents undergo a great change, which exactly resembles the change that occurs in the contents of the parent-cells and special-parent-cells of pollen when the formation of free cells is about to take place in their interior. The mucilaginous matter, or protoplasm, which was at first almost colourless, acquires a deep yellow colour, becomes much thicker, and exhibits a quantity of globular bodies which look like drops of oil. These globules are often described as granules, and some authors have mistaken them for drops of oil; others regard them as vesicles or vesicular cavities in the protoplasm; I believe them to be globular drops of the yellow protoplasm; they sometimes become confluent, but are not oil, since they acquire a brown colour, like the rest of the contents, with iodine, and are not dissolved by ether. They may acquire the appearance of vesicles by becoming coagulated on the surface, as this yellow protoplasm is readily coagulated even by water, but very strongly by alcohol or acids. The cells become filled with globules of this kind of all sizes, sometimes occupying half the cavity of the cell, but neither before nor after their formation did I meet with nuclei.

Soon after the cells become free, the yellow contents exhibit lighter streaks running across, which denote that they are separating into four portions; these are at length completely isolated and become coated by a proper membrane. They are the spores, and by the solution of the membrane of the parent-cells they become free. When free the contents become again clear and almost colourless, then the membrane becomes thickened and of a bright yellow colour, and the contents are changed into globules of pretty regular size which fill up the cavity. I never saw any trace of septa dividing the parent-cells into chambers, such as we meet with in the special-parent-cells of pollen. When the parent-cells in which the contents had parted into four portions were ruptured at one place, all the contents passed out and the membrane remained as a simple sac. When iodine was applied at the same stage, the portions were strongly coagulated, while the parent-cells expanded, but no trace of septa appeared.

Mohl states that the parent-cells of the spores of *Anthoceros lævis* are first divided into four chambers by septa, and that the same occurs in *Jungermannia epiphylla*, in the last of which the parent-cell divides into four separate cells, each containing a spore; which condition Mirbel asserts to be universal in the formation of spores. I could find no evidence of it; and Gottsche says, with regard to *Haplomitrium Hookeri*, that the empty parent-cells present marks which make them look as if they were chambered, but that all the spores pass out at one opening. It is quite possible that the enlarging spores cause the marks by their pressure against the enclosing membrane.

I could only distinguish a single coat to the ripe spore, and this grows out into a tube at one point in germination. The entire spore with its contents becomes colourless during this process, the yellow colour and the globules disappear, and after a short time chlorophyll-vesicles appear, which, when iodine is applied, are seen to be imbedded in a coagulable, colourless protoplasm. Mohl states that the spores of *Anthoceros* have two

coats, while Gottsche says that *Pellia* and *Blasia* have a single-coated spore, and *Fimbriaria* and *Preissia* apparently have two coats. I believe that this point can only be determined with certainty when the spores are germinating, and observation of this process leads me to the result that the membrane is simple in *Marchantia polymorpha.*

In conclusion, I cannot refrain from directing attention to the striking circumstance, that I met with no nuclei throughout the whole course of development. Mohl, in his essay on *Anthoceros lævis*, describes a series of phenomena connected with the appearance of nuclei, of which I saw nothing in *Marchantia*; neither did I see any nuclei during the development of the spores of *Sphærocarpus terrestris*, which I partially traced last spring. Sometimes the globular bodies in the yellow protoplasm present appearances which might be mistaken for nuclei, but careful investigation always led me to believe that these appearances were deceptive; and as I obtained clear and well-defined views of all the various stages, with fully sufficient magnifying powers to see nuclei if present, I am compelled to deny their existence here.

The main point, however, to which I wish to direct attention in this paper, is the singular manner in which the subdivisions of the cells take place, in order to produce the very dissimilar forms of long filiform elaters and spherical spores, from a tissue originally homogeneous.

London, Nov. 10th, 1849.

DESCRIPTION OF THE PLATE.

Tab. XI.

Fig. 1. A pistillidium containing the nascent sporangium at the bottom.

Fig. 2. More advanced sporangium *a*, enclosed in the membranous involucel, *b*, formed from the pistillidium. *c*. The outer involucre laid open.

Fig. 3. Portion of the wall of the sporangium 2 *a*, formed of cubical cells filled with chlorophyll.

Fig. 4. *a*. Two ripe capsules with their burst proper involucels, displayed by laying open the outer involucre; *b* and *c*. bursting sporangia.

Fig. 5. *a*. Portion of the elastic wall of the capsules 4, *b* and *c*. *b*. Two cells from the same, one with a spiral fibre, the other annular.

Fig. 6. Contents of the sporangium 2 *a*, consisting of broad and slender tubes.

Fig. 7. *a*. One of the broad tubes with the contents coagulated; *b*. one of the narow ones (elater).

Fig. 8. More advanced condition, with cross lines indicating the formation of septa: *a*. coagulated in water; *b*. by iodine.

Fig. 9. More advanced stage: *a*. fresh; *b*. with iodine.

Fig. 10. Later stage; the protoplasm becoming thickened in some cases. Vertical septa forming in some cells: *a*. in water; *b*. with iodine.

Fig. 11. Single and double rows of cells formed from the tubes, 7 *a*.

Fig. 12. *a*. Rows of parent-cells; *b*. young elater containing starch-granules; *c*. part of the same with iodine.

Fig. 13. Parent-cells in which the contents are beginning to produce the spores; the single one a free parent-cell in which the portions exhibit a membrane.

Fig. 14. Free parent-cells about to produce the spores.

Fig. 15. Parent-cells treated with iodine; the portions of contents coagulated and the membranes swelled; some cells burst and emitting contents. No trace of septa.

Fig. 16. *a*. Young spores become free, or adhering together in twos and fours, after the solution of the parent-cells; contents almost colourless; *b*. elater with the fibres appearing; *c*. portion of an elater more magnified to show the undefined appearance of the fibres.

Fig. 17. Ripe spores, bright yellow and filled with granules.

Fig. 18. Perfect elater.

Fig. 19. Portion of the same more enlarged.

Fig. 20. The end, to show the continuous condition of the fibre.

Fig. 21. Germinating spores: *a*. the membrane brownish, no contents visible; *b*, *b*, *b*. membranes hyaline, a few chlorophyll-vesicles formed; *c*. treated with iodine which colours the whole brown, and shows granular contents. The dark spots are the deep brown chlorophyll-vesicles.

The measurements are fractions of an inch.

A. Henfrey Esq. del.

G. Jarman sc.

XIII. *The Ternstrœmiaceous Plants of Hong Kong.* *By* Captain Champion, 95*th Reg.* *Communicated by the* President.

Read November 5, 1850.

Considering the great success of the *Camellia Japonica* as an ornamental greenhouse plant, it appears remarkable that but little attention should have been paid to the introduction into England of other plants of that order from India and China. Both the Camellias and Gordonias are trees or shrubs of very great beauty, and of rather hardy growth; in tropical climates restricted to elevations, where the climate bears affinities to more northern temperatures; and in China they flower alongside of the Azaleas so successfully introduced into England. Polypetalous, they hold out to the horticulturist the probabilities of increased beauty through judicious and successful cultivation.

The species of *Camellia* at present best known in England has been principally introduced from Chinese gardens. Without detracting from the good taste of that nation, in having selected elegant species, and brought their flowers to a degree of improvement which alone might have been expected from English industry, it is to be presumed that many species (some of which have been described by Loureiro) remain, in the wilds of Southern China, uncultivated.

The Chinese are in some respects *bizarres* in their admiration of plants; they have their favourites, and they are permanent favourites; not the fashion of the day, but of centuries; and these alone they cultivate, although we are acquainted, through Mr. Reeves and through Mr. Fortune, with other plants of great beauty, which are less admired by that nation. Should at any period English taste extend itself to others of the Camellia tribe, we must principally look for them from the Celestial Empire. The plants about to be described are indigenous to one small island.

Genus Camellia, L.

1. Camellia spectabilis; arborea, foliis lanceolatis acuminatis glabris crenatis subtùs reticulatis, floribus solitariis magnis albis axillaribus et subterminalibus, sepalis coriaceis fructibusque pomi magnitudinis sericeis.

Hab. in insulâ Hong Kong, Sinarum, in sylvis.

A small tree; flowering also as a shrub. Branchlets light ferruginous. Leaves alternate, short-petioled, elongate-lanceolate, with a long acumination, crenated and pellucid on the margin, coriaceous, smooth and shining; pale beneath and reticulately veined. In dried specimens the leaves turn yellow like those of a *Symplocos*; they are under 5 inches long by 14 lines broad. Flowers about $2\frac{1}{2}$ inches across; sepals 9–11, imbricated, obtuse, yellowish green and very sericeous, coriaceous. Petals about 7, white, roundish-obovate, emarginate. Stamens very numerous, gamboge-yellow. Style

sericeous, splitting a quarter of its length into 3–4 styles. Ovary 3-celled, each cell 2-ovuled. Fruit the size of a small apple, retaining at base the persistent sepals, and like them very sericeous. Seeds several, pretty large; the outer coating chestnut-coloured. Flowers in May, and fruits in November. It is a very handsome species, quite distinct from *C. oleifera* (Abel), of which I have seen specimens, through the kindness of Mr. Bennett. The petals of dried specimens turn dark yellow. I have endeavoured to introduce this species.

2. *Camellia Japonica*, Linn.

Of this but two trees are at present known in Hong Kong, growing wild, and discovered by Lieut.-Colonel Eyre, of the Royal Artillery. It is a moderate-sized smooth tree, loaded in October with single pink flowers. The fruit is smooth and much smaller than in the last species, rather above an inch in diameter. The petals, about 7, adhere at base into a ring, and are soon detached and fall off. The sepals are slightly sericeous, and the leaves more elongate than in most of the cultivated plants.

3. Camellia salicifolia; arbuscula, ramulis pubescentibus flexuosis, foliis subsessilibus elongato-ovatis acuminatis serratis pubescentibus, floribus parvulis albis, sepalis acuminatis pubescentibus, capsulis glabris parvis rostratis 1—3- sæpiùs monospermis.

Hab. in insulâ Hong Kong, Sinarum, in sylvis.

Sepals 5–7, subulate, hairy exteriorly, imbricated and subtended by imbricated, hairy bracteoles. Petals 5; white, oblong-ovate to obovate, gamopetalous at base, sericeous exteriorly. Stamina very numerous, in four rows; outer rows united into a tube; two inner with nearly free filaments. Style hairy, simple, elongate. Stigmas 1–3, filiform. Ovary hairy, 2–3-celled, each with a double row of 3 anatropous ovules. Capsule roundish-rostrate, usually by abortion 1-seeded; rarely 3-celled, 3-seeded. Leaves nearly sessile, softly hairy. Flowers nearly sessile, about an inch in diameter. Fruit from 5–7 lines in diameter. Flowers pendulous, scentless, white. It is a rather pretty undertree with long, weeping, rather brittle branches; the young leaves are reddish. Seed usually subglobose, with large, almost conferruminate, plano-convex cotyledons and a minute radicle. As species, it and the next are near to *C. caudata*, Wall. Mr. Braine has lately introduced a plant of it into the Kew Gardens. It flowers throughout autumn (October to January), and the fruit succeeds the flowers very rapidly. *Tricondyle pulchripes*, White, frequents this tree.

4. Camellia assimilis; frutex, ramulis glabris, foliis subsessilibus lanceolatis acuminatis serratis glabris, floribus parvulis pendulis albis, sepalis sericeis obtusis, capsulis glabris parvis rostratis.

Hab. in insulâ Hong Kong, Sinarum, in Monte Victoria et Monte Gough.

I have seen this species growing almost alongside of the last, and the general resemblance is very striking. Its smooth habit, shorter and wider leaves, and more especially the difference of shape in the sepals, form the distinction. Its form is more stunted, and

it grows amongst rocks and ravines. Its pretty pendulous flowers come out about January.

Thea Bohea, Linn., is cultivated in Hong Kong, but is not indigenous to it. It frequently forms borders to garden beds, just as we employ the Box. As a genus there seems to be no good distinction from *Camellia*.

Genus Eurya, Thunb.

1. Eurya Macartneyi; dioica frutescens glabra, foliis majusculis coriaceis subellipticis margine revolutis serrulatis, floribus majusculis; ♂ staminibus 19–22; ♀ stylis distinctis revolutis, fructibus purpureis, circiter 14-spermis.

Hab. in insulâ Hong Kong, Sinarum, in sylvis rupibusque. Floret et fructus fert ab Augusto usque ad Novembrem.

It is easily distinguished from *E. Japonica*, Thunb., by its larger (4 in. 2 lin. by 1 in. 7 lin.), more slightly serrated and revolutely margined leaves, their venation (grossly reticulated), and the size of its flowers; also by the styles of the female flowers being free to near their base. There are frequently black glands on the under part of the leaf. The male flowers are $3\frac{1}{2}$–4 lines in diameter, 2–5 on each peduncle, and slightly fragrant. Sepals orbicular, purplish, fimbriated, emarginate. Petals oblong-obovate, obtuse, white; patent in the male and revolute in the female flowers; the latter only $1\frac{1}{2}$ to $1\frac{3}{4}$ line in diameter. Male flowers without remains of an ovary. Anthers oblong, shortly apiculate. The petals are united at base into a tube, like those of *Symplocos*. The ovary of the female is 3-celled, each cell 5–10-ovuled; the ovules in place of being suspended are attached horizontally to the central axis.

It is a shrub 6 to 8 feet high, and as a species comes near to *E. elliptica* of Gardner.

This species has also been brought from China by Lord Macartney, and exists without name in the Herbarium of the British Museum.

2. *Eurya Japonica*, Thunb.
Eurya Chinensis, R. Br.

These two species I find mixed up indiscriminately in my collection, and believe them to be identical. It is a species subject to considerable variety, flowering profusely about October.

The fruit is dark purple, and the size of a pea, 9–10, or, in poor specimens, fewer-seeded, and crowned by the styles, which remain, even then, combined two-thirds of their length; their revolute free portions eventually falling off.

The male flowers are first greenish, then white, and have a nauseous smell; 2–3 together on each peduncle, and $2\frac{3}{4}$–$3\frac{3}{4}$ lines in diameter. Stamina 13–15 in one series. Ovary of the male flowers abortive with remains of one style. Specimens grown on barren hills are fewer-flowered than those growing in damp woods, and often smaller-leafed, and then constitute Mr. Brown's *E. Chinensis*, collected by Abel. The fruit is pea-shaped, 3-celled with about 3 seeds in each cell, attached at first to a placenta suspended from the apex of the axis. The berry is then succulent and nearly dry; finally, it becomes filled with

purple mucilage, which nearly obliterates the cells. Seeds small, triquetrous, wrinkled. Flowers and fruit, October, November and December. The female flowers are one-third less than the male flowers in size, and scentless. The pubescence or smoothness of the ultimate branches I believe to be entirely local.

I obtained excellent specimens of male and female flowers and ripe fruit, all within a few yards of each other, on December 6th, 1848.

Genus Pentaphylax, Gardn. & Champ.

1. P. euryoides, Gardn. & Champ. (Tab. XII.)

This new genus is described by Dr. Gardner in Hooker's 'Journal of Botany,' No. 8. p. 244–246. The species grows to an undertree of great beauty when in flower, and is exceedingly common in the Hong Kong woods. The flowers are small and white, and owing to those lowest on the branch expanding first, the pseudo-racemes when coming into flower present a pyramidal form with the leaves at their extremity, and have a very peculiar effect. The tree blossoms most profusely. The seed is dry, and its coating membranaceous; the embryo conduplicate; its radicle terete and cotyledons plano-elongate-cylindric. Flowers in summer and fruits in autumn. The definite 5 stamina, anthers opening by terminal pores, and the fruit resembling that of a *Gordonia* on a small scale (but with the embryo conduplicate), render it a very interesting genus.

Genus Ixionanthes, Jack.

1. Ixionanthes Chinensis; subarborea, foliis petiolatis alternis glabris integris elongato-ellipticis apice emarginatis reticulatis, corymbis longè pedicellatis axillaribus pluri-floris dichotomis, staminibus 10 longissimis, capsulis supra-uncialibus. (Tab. XIII.)

Hab. in insulâ Hong Kong, Sinarum, in sylvis.

A small tree with reddish brown bark; the leaves nearly 5 inches long by $1\frac{1}{2}$ inch broad, much reticulated and chartaceous. The 5 cells of the ovary are 2-ovuled (pendulously arranged by pairs), and in the fruit the seeds are naked, winged, and like those of a *Gordonia*, to which genus its capsule approaches. The tree was originally referred to *Cedrelaceæ*, but is now very properly classed with *Ternstrœmiaceæ*. Its sticky flowers and long filiform stamina are very peculiar. Several of the seeds which I sent to Kew have vegetated.

Upon referring to Dr. Jack's description of the Sumatran species, *Ixionanthes reticulata*, Jack, I feel some doubts as to the Hong Kong plant proving a new species. It differs in the increased size of the leaves (5 in place of 3 inches long), and probably on comparison will do so in some other particulars.

Genus Gordonia, Ellis.

1. G. anomala.

Polyspora axillaris, Sweet.

This highly ornamental tree is very common wild on the hills and in the woods of Hong Kong, and is much cultivated in that colony. Its large, white, sleepy, Cistus-like

flowers are sweet-scented, and nearly 3 inches in diameter. Its capsule large and woody. Flowers in autumn, in cold weather.

Genus Schima, Reinw.

1. S. superba, Gardn. & Champ.

Already described in Hooker's 'Journal of Botany,' No. 8. p. 246. Flowers in May, and fruits in October to December. Its bunches of large white flowers resemble *Mesua* at a distance. The fruit is nearly 10 lines in diameter, subglobose and splits into 5 valves, each containing 3 compressed reniform seeds. The embryo is curved, radicle terete, cotyledons large, and conforming to the shape of the seed.

A very rare tree in Hong Kong, except in the woods near the top of the slopes over Little Hong Kong, where it grows abundantly.

Genus Cleyera, Thunb.

1. Cleyera fragrans; arborea, tota glabra, ramulis di–tri-chotomis, foliis lanceolatis margine integriusculis leviter revolutis coriaceis, ramulis floribundioribus, floribus axillaribus pallidis fragrantibus fugacibus solitariis bibracteolatis, sepalis fimbriatis petalisque glabris parvis, staminibus brevibus glabris; connectivo acuto, stylis 2 profundè divisis; stigmatibus reniformibus, fructibus globosis diametro subsemi-uncialibus.

Hab. in insulâ Hong Kong, Sinarum, in sylvis. Fl. Maio et Octobri. Fruct. Octobri et Novembri.

A small tree, with numerous sweet-smelling pale yellow flowers, which blow in the morning and fall off before evening; the petals are combined into a ring, and are $2\frac{1}{4}$–$2\frac{1}{2}$ lines in length. The leaves (about 3 inches long by 13 lines broad) are bright green above, pale or rust-coloured beneath. Peduncles longish, reflexed, 1-flowered. Sepals 5, oblong, fimbriately crenated. Bracteoles 2, ovate, fimbriated on the margin. Petals gamopetalous, oblong-emarginate, smooth, margin uneven. Stamina very numerous, filaments about a line long. Anthers bursting longitudinally; connective small, acuminated. Ovary conical, 2-celled; each cell with 2–3 collateral pendulous ovules. Style profoundly cleft; stigmas reniform.

Fruit usually 5 lines in diameter, dry and finally hard, orange-brown with reddish spots, globose, 2-celled, each cell 1–2-seeded. Seeds thickish, small ($2\frac{1}{4}$ lines long), and covered with a thin coating of oily scarlet mucilage, dying as in *Bixa*. Testa hard and bony, with a conduplicate embryo; radicle terete; cotyledons plano-cylindric.

This may prove to be an *Anneslea*, Dr. Wallich's genus; his species is described with a 3-celled ovary. This tree constitutes much of the woods of Hong Kong.

2. Cleyera dubia; frutescens, tota glabra, foliis lanceolatis margine integriusculis læviter revolutis coriaceis, floribus majoribus ($8\frac{1}{4}$ lin. diametro) axillaribus pallidis bibracteolatis, sepalis fimbriatis petalisque glabris, staminibus brevibus; connectivo acuto, stylo sæpiùs trifido, fructibus globosis diametro supra-uncialibus.

Hab. in insulâ Hong Kong, Sinarum, in Monte Victoria. Floret Februario et Martio. Fruct. Junio.

I have doubts as to this being really different from the last. Their general resemblance is very striking, and the only specific differences I can perceive are, that here the branchlets are more swollen, ash-coloured, and less compact, the flowers larger, nearly scentless, and the petals less fugacious. The fruit and seeds are much larger; differences which might also be effected by situation. The fruit is usually 3-celled, and the seeds 4½ lines long. The species of *Cleyera* are of very difficult discrimination. This species occasionally flowers when the young leaves are coming out.

EXPLANATION OF THE PLATES.

Tab. XII.

Fig. 1. Flowering branch of *Pentaphylax euryoides*:—natural size.
Fig. 2. Fruit:—natural size.
Fig. 3. Front view of a flower:—magnified.
Fig. 4. Stamen and two petals:—magnified.
Fig. 5. Bracteoles, sepals and style:—magnified.
Fig. 6. Ovary, cross section:—magnified.
Fig. 7. Fruit:—magnified.
Fig. 8. Fruit, vertical section:—magnified.
Fig. 9. Seed:—magnified.
Fig. 10. Seed, section showing the embryo:—magnified.

Tab. XIII.

Fig. 1. Flowering branch of *Ixionanthes Chinensis*:—natural size.
Fig. 2. Flower:—magnified.
Fig. 3. Young fruit:—slightly magnified.
Fig. 4. Cross section of ovary:—magnified.
Fig. 5. Vertical section of ovary, showing the torus.
Fig. 6. Fruit burst:—nearly natural size.
Fig. 7. Seed:—magnified.
Fig. 8. Embryo:—magnified.

Ashhurst Lodge, Sunning Hill,
November 1st, 1850.

Capt Champion del. G Jarman sc

Trans. Linn Soc Vol. XXI. p.116. t.13.

Capt Champion del

G. Jarman sc

Ixonanthes [illegible]

XIV. *On the Development of Ferns from their Spores.*

By ARTHUR HENFREY, *Esq., F.R.S., F.L.S. &c.*

Read June 15, and November 2 & 16, 1852.

THE remarkable discoveries published by Count Leszczyc-Suminski in 1848, together with those to which they may be supposed to have led, in the allied families of the *Cryptogamia,* in the researches of Messrs. Hofmeister and Mettenius, are of a character to excite the strongest interest among vegetable physiologists, from the important changes which they appear to necessitate in our general views of the reproduction of plants. It is certain, moreover, that they equally deserve the attention of animal physiologists, since the phenomena which have been described seem to point directly to a much closer relationship between the characters of the sexual reproduction of plants and animals, than has of late years been considered probable; for, while the facts which have been demonstrated in reference to the mode of fertilization in flowering plants seemed to remove the possibility of tracing any satisfactory analogy,—the pollen-tube differing so widely from the spermatozoon,—a new set of conditions have been revealed in plants, which present the strongest resemblance to those met with in the fertilization of animals. Still more, the remarkable biological conditions known in the Animal Kingdom under the title of 'Alternations of Generations' are found to occur in the Vegetable Kingdom in a much more definite manner than was supposed, presenting all the distinctness which characterizes them in animals, and by no means confined within the debateable territory in which they were at first sought, namely, in the metamorphoses of the organs of single plants.

The observations of Suminski naturally attracted the attention of the more active vegetable anatomists, and have already been repeated by several German botanists, whose results, however, not only differ in many points from those of Suminski, but also among themselves; and opinions are divided both as to the actuality of the existence of the most important point of all, viz. the process of impregnation, and as to the period and circumstances of its occurrence. Thus, while Von Mercklin confirms Suminski's statements in regard to the act of impregnation taking place at an early period, Schacht and Wigand deny it altogether; and, again, Hofmeister and Mettenius assert the fact of the impregnation of a germ-cell by spermatozoids, but declare that Suminski mistook the structure of the organs and the *modus operandi* of the phenomenon.

Under these circumstances I believed myself performing a useful task in subjecting the question to minute investigation. These researches were indeed commenced immediately after the publication of Suminski's treatise, but were left imperfect until the past winter and the present spring, during which I have carefully repeated all my former observations, and traced the development entirely through from the spore to the young leafy plant, applying every available means to clear up the anatomical conditions in each

stage of the progress. The extreme delicacy of the young prothallium renders dissection a matter of some difficulty, and, as in the embryotomy of flowering plants, the anatomist, with all the skill acquired by practice, must be content to obtain decisive observations in but a very small proportion of his preparations.

The drawings which accompany this Memoir were nearly all made by means of the camera lucida eye-piece, so that they represent preparations actually seen; the unimportant details alone, such as the green colouring matters, &c., being given in a conventional manner, except in a few separate figures devoted to the special illustration of these points.

The first part of the Memoir is devoted to an account of my own observations; to this is added a critical examination of those of preceding authors; and, in conclusion, a few remarks on the general bearing of the results upon vegetable physiology.

As some foreign vegetable anatomists have been inclined to lay great weight on the quality of their microscopes, in discussing the points in dispute between different observers, it may be as well to state, that my investigations were made with one of Ross's large microscopes, with his 1-inch, $\frac{1}{2}$-inch, $\frac{1}{4}$-inch and $\frac{1}{8}$-inch objectives (about seven or eight years old), and the drawings sketched in with the camera lucida eye-piece, after the preparations had been fully observed with various other eye-pieces. The $\frac{1}{4}$-inch objective sufficed for most purposes; the $\frac{1}{8}$-inch was useful for the spermatozoids, but in regard to anatomical points was chiefly used on account of the short focus, which is often advantageous where the lines of cell-walls cross above one another. The most important point, however, is the clearness of the preparations observed, and on these I place my dependence as to the accuracy of my statements, since there can be no doubt of my microscope being quite equal to those of foreign investigators.

I. The Prothallium.

The specimens which I investigated were obtained from the Chelsea and Regent's Park Botanic Gardens, consisting in a great measure of self-sown plants collected from the pots of ferns growing in the stoves. Hence I am unable to give a very definite statement as to the species of ferns on which I made my observations, and can only say that they were chiefly species of *Gymnogramma*, *Adiantum*, *Pteris* and *Asplenium*; this is of the less consequence, since the phenomena appeared to differ very little in the different specimens in which specific distinctions were certainly known to exist.

Plants of *Gymnogramma chrysophylla* and of an unknown fern were obtained in the earliest condition, for among the tufts of young *prothallia* placed beneath the simple microscope for separation, I often found the burst capsule of the parent plant, with the spores germinating within and growing out from it. Examination of these showed that the first change which occurs in the spores is the bursting of the outer tough coat and the protrusion of the delicate inner membrane as a kind of pouch, like a pollen-tube from the pollen-grain; this tubular process grows longer, and sooner or later becomes divided by a cross partition into two cells (figs. 1 & 2); this is sometimes formed near the spore; in other cases the first cell is produced into a long filament before the cross-wall is formed, and the latter then partitions off a small portion at the end. The second cell becomes

elongated in like manner and again divided, and sometimes this goes on until a row of five or six cells is formed (figs. 3 & 4): when the first cell grows out into a long filament, fewer cells are formed in the simple row. Chlorophyll granules show themselves, increasing in quantity in the newly-formed parts. The first formation of radical fibres often occurs in the earliest stages, consisting in the growth outward of the wall of one or more of the cells of the filamentous *prothallium* into a slender tube, which attains a great length, remaining narrow and uniform in diameter, and never having its cavity cut up by partitions. All the roots met with on full-grown *prothallia* exhibit the same characters; they are tubular prolongations from the inferior walls of cells of the green, vegetating, frondose expansion, and their tubular cavities are freely open into those of the cells from which they arise.

After a time the youngest cell of the growing *prothallium* becomes more expanded in the transverse diameter, and after the next transverse subdivision of the cavity we find a new mode of increase, namely, a division of the newest cell in a direction parallel to the original direction of growth; by the frequent repetition of these two modes of extension the *prothallium* gradually acquires a somewhat three-sided figure, with the angles rounded off (figs. 5, 6 & 7). When it has attained a certain size a difference begins to present itself in the degree of expansion of the new cells continually formed by subdivision; those in the middle of the front border (that directly opposite to the original point of growth) remain small and are greatly surpassed in size by those at the sides and at the two anterior angles, so that the latter advance forward as rounded lobes, leaving a notch or excavation in the middle, giving the entire *prothallium* the form which in leaves, &c. is termed obcordate (fig. 9). In the meantime great quantities of radical hairs are developed from the lower faces of the cells in the neighbourhood of the obtuse apex of the heart-shaped frond, that is, about the *posterior* part of the *prothallium*, which generally exhibits a very ill-defined margin, as the cells formed at first often decay away and disappear, leaving a ragged edge (figs. 9 & 10).

While the cordate form, which varies a good deal in different species in the lateral expansion of the two lobes, is becoming perfected, the middle and posterior region of the *prothallium*, near where the roots arise, begins to display a new mode of growth. Up to this time the entire *prothallium* consists of a single flat layer of cells, in which state the lateral lobes and the anterior border persist, but in the central and posterior part the cells now become divided by horizontal walls, so as to give the *prothallium* a thickness of two, three, or more cells in the vertical section (figs. 62 & 67). The thickened portion forms a rounded cushion-like projection from the inferior face of the *prothallium* (fig. 51), while the upper surface remains flat or is even slightly depressed in the region over the thickening.

The characters presented by the cells are as follows:—their walls are delicate and closely in apposition, so as to leave no intercellular passages between them; they are lined by a layer of mucilaginous consistence (the primordial utricle) enclosing a clear fluid filling the cavity of the cell. This substance is coagulated and contracted by acids and iodine, so as to collect all the cell-contents into an isolated mass in the centre. In the cell are also found, more or less abundant, chlorophyll globules, some imbedded in the mucilaginous

layer lining the wall, others lying in the more internal parts of the cavity (fig. 13). In some cases the chlorophyll globules are so closely packed, in isolated cells, as to acquire a parenchymatous form from mutual pressure (fig. 14). These chlorophyll globules present in a high degree those characters found in the same structures in all the higher Cryptogamous plants,—characters which appear to warrant Nägeli's view that the chlorophyll is contained in a membranous vesicle, and that these vesicles are increased in number by a process of subdivision like that of cells. I have met with appearances which I cannot explain in any other way, but shall be content with a mere indication here, to avoid digressing from the immediate subject of this Memoir. I believe that I have seen the enveloping membrane enclosing a green fluid (fig. 15); moreover, the development of two or more starch-granules inside those vesicles, so as gradually to displace the chlorophyll; but as the vesicles are only about $\frac{1}{8000}$th or $\frac{1}{10,000}$th of an inch in diameter, much careful examination is requisite before a safe decision can be arrived at.

In some cells I have seen a small colourless and formless accumulation of mucilage upon the side wall, among the chlorophyll globules. It is possible that this may have been a nucleus. I also found a large clear and circular vesicle in one of the cells of an old barren *prothallium*; this had all the appearance of a nucleus, excepting that it was so exceedingly transparent. In the vegetative cells generally I saw no trace of nuclei.

The cells of the older posterior part of the *prothallium* contain but little chlorophyll, and like the root-filaments, are filled with colourless, slightly granular mucilaginous fluid; and they often appear stained with brown patches, arising from the partial decay of the walls. In all cases the death of the cell-membrane is followed by a brown colouring of the dead part.

Such is the normal history of a *prothallium*, so far as its vegetation is concerned (for the reproductive structures, left out of view in the preceding description, are in part developed at a very early period). If the regular development of a leafy stem takes place, a term is naturally set to the existence of the *prothallium*, which quickly decays away as the young stem grows up. But if the *prothallium* remains barren, if none of the *archegonia* become fertilized, its vegetative existence may be continued for a long time. The lateral lobes grow much larger, their borders become curved and sinuous, or variously convoluted; new lobes sometimes grow out from the cushion-like thickening in the middle; and, finally, individual cells of the margin may grow out and repeat the mode of development exhibited by the spore-cell in the original germination, so as to produce new *prothallia* (by a process of budding), which become detached from the parent (fig. 12). The progeny of 'proliferous' *prothallia* exhibit *antheridia*, but I have never seen *archegonia* upon them. In other respects they are exact repetitions of the parent structure.

II. The Antheridia.

The organs to which this name is applied are produced in much greater abundance than those which are indicated by the term *archegonium*, and they present themselves throughout almost every stage of the growth of the *prothallium*, in some cases from the time when it consists of a mere collection of some dozen cells, in others not until the cordate form has become evident, until the latest period; so that since they run through their

course of development in a comparatively short space of time, we have them coexistent in every condition of their development in *prothallia* which are fully formed. When *antheridia* appear on very young *prothallia,* composed of a single row of cells, or at most of a double row in the upper part, they present themselves as productions from the margins, the outer side of one of the cells giving origin to each *antheridium.* But as soon as the *prothallium* has acquired anything like a flattened form, by the transverse expansion of the anterior end, the *antheridia* are formed almost exclusively upon the inferior surface, that surface in contact with the soil upon which the plant grows. They appear first upon the older cells of the central region, and gradually spread forward as the *prothallium* grows, but appear seldom to extend beyond a certain distance from the centre, occurring in greatest number about the central cushion-like protuberance above described.

It has already been stated that they occur upon the progeny of the proliferous barren *prothallia*; in some cases I have found these branching at their edges and bearing *antheridia* in a very abnormal position, at the ends of projecting cellular processes (figs. 27–32); this, however, afforded great facility for observing the internal structure of these organs, and checking the results obtained by observations upon sections.

The first sign of the production of an *antheridium* consists in the elevation of a globular protuberance from the lower, free surface (or in the young *prothallia* from a lateral surface), forming at first a kind of globular pouch (fig. 17), in which are seen at first a few chlorophyll globules, which afterwards vanish and give place to a collection of light yellowish, mucilaginous contents, slightly granular. A septum is soon formed, shutting off this budding cell from that which gives origin to it, and as it becomes elongated another cross septum often appears, a little higher up (figs. 21 & 29, &c.), so that the structure then consists of a basal cell forming a peduncle, as it were, for the proper antheridial structure. This occurs most distinctly in marginal *antheridia* (figs. 27–32).

The antheridial structure, at first consisting of a simple cell, exhibits a considerable collection of protoplasm occupying the greater part of its cavity; but this portion soon becomes defined by a circular wall, which makes its appearance simultaneously all round the central contents, converting the simple cell into a compound organ, consisting of a central cell surrounded by an annular cell; while a horizontal septum is formed above and at right angles to this, cutting off a new cell, convex above and flat at the surface, in contact with the contents.

In *antheridia* produced on young *prothallia,* the enveloping tubular cell surrounding the central cell (the parent-cell of the *sperm-cells*) does not always undergo further subdivision, but in fully developed specimens (when the basal, peduncular cell is often absent) the tubular cell appears to be divided into two by a horizontal septum running all round. This wall is seen most clearly in old *antheridia* which have discharged their contents (figs. 48, 49).

The central cell meanwhile acquires an increased quantity of protoplasm, which also appears to become more dense; these contents by their increase cause the walls of the cell to bulge out in all directions, and at a certain stage they seem to press so much upon the inner wall of the annular cell, forming the boundary of the central cell, as to push it quite against the outer wall, in fact so as to flatten the boundary cell, and for the time to efface

its cavity. The same takes place upwards and downwards, and thus the *antheridium*, when examined in this state, seems to consist merely of one large cell (figs. 21, 22 & 26), with rather thick walls consisting of a double membrane (figs. 24, 25).

While in this expanded condition the entire structure increases in size, and the contents of the central cell become more granular. After a time faint lines can be detected running through the *protoplasm* (fig. 21), and these soon display themselves more clearly as the boundaries of square isolated masses of the protoplasm (figs. 22 & 25), the nascent *sperm-cells*. Around each of the little masses thus isolated a membrane is formed. It was impossible to ascertain whether the parent-cell was first divided into a number of square partitions, by cross walls, thus producing "special parent-cells," for the *sperm-cells*, like those formed in the development of pollen-grains, the original partitions subsequently becoming dissolved to set free the cells thus originally connected together; or, whether the protoplasm was simply entirely broken up into a number of isolated portions, each of which secreted a membrane and thus formed a free cell; but I incline to believe that the latter was the fact, and that the same occurs in the completely similar case of the production of a number of closely packed endosperm-cells, in the embryo-sac of many Phanerogamia, as in the Cruciferæ and Scrophulariaceæ*. However this may be, the result is the production of a large number of free cellules, filled with mucilaginous protoplasm (figs. 26, 34), of a light yellowish colour, becoming gradually more and more granular. As these cellules, at first squarish, enlarge, they become spherical, and by their expansion distend the parent-cell and disguise the existence of the annular cell surrounding it. Their number, in well-developed *antheridia*, seems to be between thirty and forty, probably never exceeding the latter number.

The free cellules, the *sperm-cells*, become more and more opake and granular, and after a time spiral lines may be detected in them, while still within the parent-cell in the *antheridium* (figs. 35 & 36). At this time the *antheridia* may be burst very easily by pressure (fig. 36), and the *sperm-cells* which escape can be observed in all stages of development, until a spiral fibre can be clearly seen, coiled up in the interior. Specimens lying in water, under the microscope, now frequently exhibit a movement of the contents of the *sperm-cells*, they swell up, and the spiral lines are seen to change their position. Very often the bursting of the *sperm-cells* takes place within the *antheridium*, and the *spermatozoid* becomes free (fig. 38). But usually, and apparently normally, the cellules are discharged entire from the *antheridium*. This occurs by the splitting of the line of junction of the lenticular cell crossing the *antheridium* with the lateral cell, at first at one side and then usually all round, but sometimes it remains attached by a small portion (fig. 48). By this circumscissile dehiscence the cavity of the *antheridium* is freely opened, as when the lid is removed from a box. The *sperm-cells* begin to escape as soon as the dehiscence commences, and a large portion of them have often made their exit before the lid has completely opened.

As the opening of the lid gives a vent to the contents of the distended central cell, the tubular enveloping cell exerts a pressure inwards by striving to regain its original form, and as the *sperm-cells* are discharged, the side-walls of the central cell come back into

* I have observed it in *Lathræa Squamaria* most distinctly.

their former position so as to render the existence of the enveloping cell or cells very evident. After the whole of the contents have been discharged, the walls of the parent-cell acquire a deep brown colour, presenting a peculiar appearance and making the anatomical structure of the *antheridium* very clear (figs. 48, 49). The lower faces of full-grown *prothallia* exhibit, when moderately magnified, a great number of circular bodies with brown roundish or squarish central patches; these are effete *antheridia*, with the brown walls of their cavities showing through the orifice at the summit (see figs. 19 & 50).

We have next to consider the appearance of the *spermatozoids*, produced by the *sperm-cells*. These cells, as stated already, generally emerge entire from the *antheridium*, the spiral fibre being visible, in movement, in their interior. After a variable time, according to the stage of development of the *spermatozoid*, it breaks through the wall of the *sperm-cell*, and if perfect, escapes entirely from it. When perfect it appears to consist of a flattened band, curled spirally into about three and a half coils, bearing all along the outer edge, cilia of considerable length, vibrating with great rapidity; so much so, indeed, that they appear only like a fringe of light while the *spermatozoid* is in active motion (fig. 40). The filament when in the condition of the lowest specimen in the group (fig. 40) measures about $\frac{1}{1000}$th of an inch in length, as coiled up; the diameter of the widest coil, about equal to that of the *sperm-cell*, is usually about $\frac{1}{2000}$th of an inch. I never saw one uncoiled and flaccid but once; this measured about $\frac{3}{2000}$ths of an inch in length (fig. 42 *a*). The motion consists of a rapid rotation around its axis, which, from the spiral form, causes a motion of great velocity, forwards, in the water. The motion does not seem to follow any fixed rules; the *spermatozoids* dart here and there, turn aside or backwards, or alternately to the right and left in their course onward, so as to preclude the possibility of laying down any formula or law for it. If they come in contact by the smaller extremity with any fixed body, they often adhere by this point and then revolve around their axes without advancing. By degrees the motion becomes slackened and the rotation is lost, merely a kind of vibratory motion remains, and this at length ceases; but the *spermatozoids* seem to undergo dissolution during this time, and when they come to rest often appear as shapeless masses. By applying iodine the movement of the most active can be stopped instantaneously, and in this way a tolerably clear view of the structure is obtained. Under these circumstances the cilia may be seen pretty clearly (fig. 41); the flattened band exhibits minute granules adhering to it, and is seen to have a little rounded head, from which the coils run back, increasing successively in diameter, so as to give a conical form to the outline of the whole, as seen at the side.

Such, so far as I can make it out, is the character of a perfect *spermatozoid*. But these bodies acquire the capability of motion, of whatever nature this may be, before they are perfectly developed, and hence, I imagine, the different accounts which different observers have given of them. It seemed to me that when they had not acquired their full development, the fibres could not unroll into the true form when they emerged from the *sperm-cell*; they thus appeared to present fewer coils, often only one and a half, the latter of very large diameter; in other cases they looked like minute shells of Gasteropodous Mollusks. In fig. 46 I have given representations of several of these forms, and it should be observed that these imperfect forms exhibited a greater quantity of adherent granules, and

a less definite outline than the others. Finally, some appeared unable to extricate themselves from the sperm-cell, and carried this along attached to the posterior extremity (fig. 44). This vesicle attached to the *spermatozoid* has been described by some observers as formed by the swelling of the extremity of the filament after its exit from the sperm-cells, therefore as constituting an integral part of the structure of the *spermatozoid*; but I believe this to be an error.

In one case I saw an appearance which seemed to indicate the existence of a hair-like production of the posterior extremity of the *spermatozoid*, like that figured by Hofmeister. A *spermatozoid* moving rapidly forwards in the water dragged after it, at a little distance, a small mass of mucilage (fig. 42 *b*); the bond of connection was invisible, and therefore, most probably, must have consisted of a capillary process. I never saw any hair-like tail in specimens suddenly paralysed by iodine, but it may have escaped notice from its tenuity; on the other hand, it may possibly be only found in the most perfect state of the *spermatozoid*, and since these are examined under artificial conditions, often causing the rupture of the *antheridia* before their contents are mature, the most perfect condition may only be met with occasionally.

III. The Archegonium.

In the description of the development of the *prothallium*, it has been stated that a thickened, cushion-like mass is formed in the central region, by the time the general form has become complete (fig. 51). This central mass is composed of several layers of cells, and, projecting from the general surface, does not reach quite to the inner extremity of the anterior notch of the *prothallium*, so that an inclined surface is produced looking somewhat forwards toward the notch (fig. 52). Upon this arise the *archegonia*, which are variable in number, seldom however exceeding six or eight.

The earliest rudiment of the *archegonium* is the *embryo-sac*, as it may be termed, consisting of one of the cells of the thickened cushion, separated by a single cell from the (inferior) surface of the *prothallium* (figs. 54—57 *a*). A cell, destined to become an *embryo-sac*, is found surrounded by a circle of cells of smaller size than those of the surrounding tissue, and formed by the production of walls in the cells immediately bordering the *embryo-sac*, tangental to the circumference of the latter, which thus becomes defined by a wall of small cells surrounding it (figs. 55, 57 *b*). Cell-division also takes place in the cells beneath the *embryo-sac*, and these multiply so as to form a collection of condensed tissue enclosing the embryo-sac at the sides and below (figs. 66, 67 *b*), visible through the cells of the surface of the *prothallium* (figs. 54, 56) before the external structure is formed. The commencement of the development of this consists in the enlargement of the cell separating the *embryo-sac* from the surface, and its division into two cells by an inclined wall, the larger of these being again divided by another partition at right angles to the former, so that as seen from the (under) face of the *prothallium* (fig. 52), the superficial cell seems divided into three. I could not follow the development of the cells, step by step, onward from this point, but it is evident that they go on repeating the mode of subdivision of the first cell; that is to say, the process is as follows: the original cell, A, divides by an oblique septum into an upper, *b*, and lower, *a*, the latter being divided by a radial septum into

two, *a* 1, *a* 2; the cell *b* expands upwards, and by the formation of a septum inclined exactly in the opposite way towards the horizon, to that first formed, cuts off cell *b* into *b* and *c*; *b* is then divided by a radial septum into *b* 1 and *b* 2, while *c*, the last new cell, overlaps *a* 1 and *a* 2; another division of *c* leaves *c* 1 and *c* 2 over *a* 1 and *a* 2, and carries up *d* to form *d* 1 and *d* 2, above *b* 1 and *b* 2, until the papilla reaches its full height, and appears composed of tiers of four quadrant-shaped cells, the first tier consisting of *a* 1 and *a* 2, *b* 1 and *b* 2 of the series; the next tier of *c* 1 and *c* 2, *d* 1 and *d* 2, &c. (figs. 58–61).

In the meantime, the *embryo-sac* at the base, which very early appeared filled with opakish protoplasm, comes to exhibit a central globular body (figs. 56, 57 *c*), which in all probability is an isolated mass of protoplasm, destined to secrete a membrane around it, and to form the *germinal vesicle*, just as occurs in the embryo-sac of Phanerogamia (for example in *Orchis*). The next peculiarity is the appearance of a clavate cavity running up the centre, between the convergent inner angles of the four series of cells of the papilla, forming a canal evidently communicating, through a constricted neck, with the *embryo-sac* (figs. 62–70). In this canal is observed a slender clavate filament of slightly granular mucilage (fig. 70) running down into a point in the *embryo-sac* below, where I believe it is in contact with the *germinal vesicle*: I imagine this to be a portion of the protoplasm of the *embryo-sac* which has been protruded up into the intercellular canal of the papilla, after the absorption of the wall of the *embryo-sac*, where it at first closed the bottom of the canal at the constricted neck. After a time the canal becomes opened to the external medium, and then the clavate filament is often seen hanging out from the open mouth (figs. 63–66); it is generally double (figs. 63, 64) at the upper end, which I cannot explain. It appeared firmly attached in the canal, and bore the movements of the preparation, by pressing and sliding over the covering glass, without becoming detached from the papilla.

It is at this stage of development that I believe the impregnation to take place; but before proceeding to speak of this part of the subject, I may conclude the description of the *archegonia*, by stating that the greater part of them are abortive; very rarely more than one being fertilized on a *prothallium*, and very often none. When thus abortive the cellular papillæ continue growing to some extent, the central canal becomes widely opened, often into a large funnel-shaped orifice, and the walls of the intercellular canal and the *embryo-sac* acquire the same deep brown colour as the interior of the effete *antheridia* (figs. 72–74).

IV. Development of the Embryo.

My opinion with regard to the fertilization is, that the operation is effected by the contact of one or more *spermatozoids* with the mucilaginous filament contained in or hanging from the mouth of the canal of the *archegonium*. I have seen the *spermatozoids* swimming in numbers around the mouth of the *archegonia*, but never detected one inside, and I do not see any good reason for supposing such a process necessary. The pollen-tube of flowering plants only comes in contact with the outside of the embryo-sac, and the influence is sometimes communicated through a long suspensor; and there does not seem to be any sufficient objection to the supposition, that the contact of the *spermatozoid* with the filament of mucilage which lies in the canal of the *archegonium*, suffices to convey the

necessary stimulus. I imagine this stimulus resides in the mucilaginous fluid in which the *spermatozoid* is bathed in the *sperm-cell*, and which, adhering to this, is conveyed to the mucilage (protoplasm) of the *germinal vesicle*, just as the contents of the pollen-grain become combined with the protoplasm of the germinal vesicle in flowering plants. The nature of the process is clearly a problem beyond the reach of science, but it seems to be a necessary induction, from the facts in the Phanerogamia, that the phenomena result there from the material union of two fluids, and I hence conclude that this is the case here. The comparatively few cases of successful impregnation among these *prothallia*, so many of which prove sterile, may perhaps be accounted for by the peculiar conjunction of circumstances required to bring a sufficient amount of the fertilizing fluid, by means of the *spermatozoids*, to the *germinal vesicle*, at the precise epoch required.

Some doubt has been thrown upon the possibility of the impregnation of the *archegonia* by means of the *spermatozoids*, on the ground that the free movement of the latter in the water, beneath the microscope, is an abnormal condition. I attach no weight to these objections, for the occurrence of numerous empty *antheridia*, on moderately developed *prothallia*, proves that their dehiscence is a natural process, and if the moisture which always exists upon the under surface of the *prothallia* is insufficient to allow such a wide and free course to the *spermatozoids* as they find in the water on the glass slider beneath the microscope, we see a compensation for the obstacles in the way of the conjunction in the large number of *antheridia* produced, and this not at one time only, but throughout the whole growth of the *prothallium*. Again, there is evidence that the process is not easily and constantly completed, in the fact of so many *prothallia* remaining sterile, and in the provision of several *archegonia* upon each, while in normal cases only one produces an embryo.

Arguments have been urged against the entrance of the *spermatozoids* into the *archegonium*, from the consideration that the mouth of the canal is directed downwards, and the *spermatozoid* would consequently have to work its way upwards, contrary to the attraction of gravity; and further, from the fact that the apex of the *archegonium* is usually directed forwards towards the notch of the *prothallium*, while the *antheridia* occur principally about the posterior part. If we imagine the contact of the *spermatozoids* with the mucilaginous matter protruding from the mouth of the canal to suffice for the impregnation (it being understood, however, that this happens under such circumstances that the *spermatozoid* is fresh from the *antheridium*, and the mucilage of the canal of the *archegonium* has not yet become coagulated by exposure), this difficulty is done away.

The first result of the impregnation,—that is to say, the first step of development of the embryo, which I believe to be the consequence of such an operation,—as seen by means of vertical sections of the *prothallium*, consists of subdivision of the *germinal* or *embryonal vesicle** of the *archegonium*. In the earliest state that I have been able to see clearly, a little globe of minute cellular structure occupied the place of the *embryonal vesicle* (figs. 71, 75),

* It is unimportant which we call it, since it is here developed at once into the embryo. In flowering plants the *germinal vesicle* usually becomes subdivided to form a suspensor, and one of the cells produced by it becomes the *embryonal vesicle*.

in the *embryo-sac*. The succeeding stages of growth of this new cellular body, the *embryo*, consist of a gradual multiplication of the cells by division, and expansion of the new structure, until at length the rudiments of a radicle and the first leaf become visible as projections from the surface, resulting from the more rapid increase of the cells in the situation where they are found (figs. 76–79).

In the ulterior development of the *embryo* the radicle appears to be arrested in its development, and to remain as a cellular mass (fig. 80 *a*) within the cavity of the *prothallium*, until it disappears with the latter by decay. The first leaf unfolds upwards and forwards (fig. 80 *b*) towards the notch of the *prothallium*, and the first adventitious root (fig. 80 *c*) breaks through at the base of this towards the posterior border of the *prothallium*, exhibiting a coleorhize like that of the Monocotyledons. The second leaf arises near the axil of the first, one-third of the circumference of the nascent stem to the side; the third leaf arises one-third to the side of the second, so that the three leaves form a circle, in which they stand at equal distances, and the fourth leaf arises over the first (*Gymnogramma chrysophylla* ?). They are of very simple structure, consisting of cellular plates with twice-forked rudimentary nervures, and they are accompanied by very elegant *ramenta* at the bases of the little petioles (figs. 81–83).

I have not followed the development beyond the formation of the fourth leaf (fig. 83), by which epoch the *prothallium* has generally decayed away from the base of the young stem.

V. Criticism of previous Observations.

The first account of any of the peculiar structures above described was published in 1844 by Nägeli*, in a memoir entitled "Moving Spiral Filaments (spermatic filaments) in Ferns," wherein he announced the existence of the bodies now called *antheridia*, but mistaking the *archegonia* for modified forms of the *antheridia*, he was led away from a minute investigation of them. If he had followed the development of the *prothallia* further, he would have detected the relations of the nascent embryo, which would probably have put him on the right track. As it was, the remarkable discovery of the moving spiral filaments, or *spermatozoids*, occupied all his attention, and caused him to fall into error in certain important respects; for example, in fig. 11 of his plate, he has represented what is undoubtedly an *archegonium*, filled with cellules (*sperm-cells*), which, he states, emerged from it as from the *antheridia*: this is undoubtedly incorrect.

With regard to the *spermatozoids* his description is imperfect, the only indication of the existence of cilia being a statement that he occasionally saw a long filiform appendage, like that represented by Meyen in the *spermatozoids* of *Chara*. On the other hand, the mathematical definition of the movements of the *spermatozoids* is surely misplaced, since nothing can be more arbitrary or irregular than their course.

However, whatever be the faults of observation, it is certain that it is to the keenly inquiring spirit of this author that we owe the first step of the investigations which have thrown so much light upon the reproduction of the higher Cryptogamia.

Nägeli's observations remained without confirmation or criticism until the publication

* Zeitschrift fur wiss. Botanik. Heft i. 168. Zürich, 1844.

of the important investigations of Count Suminski, which were first made known in the 'Bulletin' of the Berlin Academy, and by a note from Dr. J. Münter in the 'Botanische Zeitung,' but were given in a complete form in a separate treatise by the author in 1848*.

These investigations, which form the basis of the subject before us, from the capital fact of the discovery of the *archegonia* and of the development of the embryo from one of these, present a curious mixture of industrious observation and preconceived theories. It is an invidious task to criticise an essay which has so greatly advanced our knowledge of the subject, but it is an unavoidable one. The great fault of the essay is the free exercise of the imagination in cases where the delicacy of the structures renders the objects exceedingly difficult to make out clearly. I feel warranted in making this assertion by the fact that my own microscope must be equal if not superior to that used by Count Suminski, since I have seen, with the greatest clearness, points which he missed, where good definition of the microscope was all that was requisite, and on the other hand, I can trace actual invention in cases where bad definition of the object would leave points obscure which I saw distinctly. Moreover, his figures display appearances which I neither saw nor can conceive the possibility of seeing with the distinctness represented in his drawings, while some of these bear patent evidence of a faulty interpretation of tolerably clear conditions.

Such assertions of course require evidence, and it is desirable that this should not rest upon counter-statements alone, but should furnish some explanation of the probable causes of the errors stated to exist.

In the first place, then, Suminski describes the growth of the cells of the *prothallium* to take place by the formation of two or more free cells within a parent-cell, expanding till they come in contact, and meanwhile displacing the chlorophyll and other contents of the parent-cell, which become absorbed and are reproduced in the new cells. This statement is opposed to all my experience of vegetative growth, not only in these *prothallia*, but in all other plants; and is evidently a hasty conclusion, arising out of a preconceived notion, —that notion of cell-formation formerly asserted by Schleiden to be universal, but now acknowledged by him to be subject to exception: for I can affirm that the growth of the *prothallium* occurs by the expansion and subdivision by septa of the cells, without important disturbance of the contents, and this process is in all probability effected through the agency of the *primordial utricle*, or layer of dense protoplasm which invariably lines the walls of the growing cells.

With regard to the *antheridia*, Suminski observed them very superficially; he describes the compound cellular body borne upon a peduncular cell, as a simple cell, discharging the *sperm-cells* by bursting. He overlooked therefore all the stages of development, from the very earliest up to the time just preceding the dehiscence, and can scarcely have paid any attention to the appearances of the effete *antheridia*. I need only refer to the observations of Thuret, Schacht and Hofmeister to prove how imperfect his account of the *antheridia* is. The *spermatozoids* inside the *antheridia*, again, and those in the free

* Zur Entwickelungsgeschichte der Farrenkräuter, von J. Grafen Leszczyc-Suminski. 4to, Berlin, 1848.

cellules, shown in Suminski's figures (pl. 2. figs. 12–16), are, like those of the *antheridia*, derived rather from the imagination than from fact.

But the most important errors occur in the account of the development of the *archegonia*. The earliest stage, as seen by looking directly upon the (under) surface of the *prothallium*, was completely misconceived by Suminski. He overlooked the cell, forming part of the general surface of the *prothallium* and becoming the parent-cell of the papilla, which, from the first, lies between the *embryo-sac* and the external medium; so that he imagined the *embryo-sac* to be open and capable of admitting *spermatozoids* into its cavity. I examined this point most carefully, and am convinced that he was in error. Any one who looks at his figs. 1 and 2 of plate 3. will see that there exists no trace in them of a cell or cells from which the papilla (seen from above in fig. 3 of his 3rd plate) could arise, for the supposed orifice is bounded by seven cells, and if the papilla sprang from these it would consist of seven vertical series instead of four. The fact is, that his fig. 1 of pl. 3, stated to be from a dissection, merely shows what is seen in looking upon the under surface of the *prothallium*, without dissection; but it represents the object focused down to the globule in the *embryo-sac*, as in my fig. 57, so that the membranes of the cells occupying the space supposed to be an orifice and forming part of the continuous surface of the prothallium (my fig. 56) are not seen. Fig. 3 of Suminski's 3rd plate shows a subsequent stage, where the papilla, composed of four rows of cells, is already developed; he has missed the gradual production of this from the cell occupying the situation of the imaginary orifice.

This clearly takes away all ground from his hypothesis of the impregnation resulting from the entrance of *spermatozoids* into the *embryo-sac* before the development of the papilla of the *archegonium*, and moreover proves that the bodies contained in the closed canal of this organ (shown in his figures, pl. 3. figs. 4–7) could not be altered *spermatozoids*. It will be remembered that I have explained these appearances in a totally different way.

With regard to the phenomena of the development of the *germinal vesicle* in the *embryo-sac*, I think it is scarcely possible to obtain such clear views of the young structures as Suminski has given, and I could only approximate to them by sections through the *prothallia*, while from his figures we are led to suppose that he saw them through the enveloping tissues, which are far too thick to allow such clear definition, especially since their contents soon become coagulated by the injury the preparation suffers in water and under pressure. All that Suminski states, therefore, respecting the development of a cellule at the end of the *spermatozoid*, inside the globular cell of the *embryo-sac*, I regard as the work of imagination, guided by a preconception of the necessity of some process analogous to that described by Schleiden in reference to flowering plants, namely, the production of the embryo from a cellule formed in the end of a pollen-tube, after the latter has become imbedded in the embryo-sac. The drawings representing the subsequent growth of the *embryo* are more or less incorrect; thus the primary, undeveloped radicle, which remains enveloped in the tissue of the *prothallium*, is not properly shown, while this cellular tissue is represented as enveloping the base of the leaf and of the first adventitious root (pl. 4. fig. 10 *f.* of Suminski's Essay), and the adventitious root itself as a direct prolongation from the base of the first leaf. The true condition is shown in my

fig. 80, where the ragged tissue (*h*) is seen to be the torn edge or collar always found where adventitious roots break out from the interior of a stem.

It is unnecessary to enter into any other points. It is seen that the only matter in which I am agreed with Suminski is the import of the organs and the existence of a sexual conjunction; in all the details of the processes I am at variance with him. Nothing, however, can take from him the credit of having discovered the *archegonia* and their import, one of the most important discoveries in physiological botany of modern times; since it has led to results revolutionizing the whole theory of the reproduction of plants, and opened out a totally new sphere of inquiry into the laws and relations of vegetable life.

The next contribution to the subject to which such a lively interest had been attracted, was a paper by Dr. Wigand *, giving a detailed account of a series of critical observations on the question, and deducing conclusions directly opposed to those of Suminski. Dr. Wigand's observations do not seem to have been complete and thorough-going, for he also describes the perfect *antheridium* as a single cell, and appears to have confounded the complex structure seen in the effete *antheridia* with that of the *archegonia* (p. 23 *loc. cit.*). His description of the development of the sperm-cells within the *antheridia* is nearer the truth; but while right in rejecting the ideas of Nägeli and Suminski, that these originate by free cell-formation around a nucleus, he fell into a different error in supposing that the cellules were not in contact at first, but were formed in groups around isolated portions of the cell-contents. His description of the *spermatozoids* is pretty accurate, but the differences he describes appear to me to indicate different stages of development, and not to depend upon the specific differences of the specimens examined. He overlooked the earliest stages of the growth of the *archegonium*, and especially the existence of the *embryo-sac* beneath the nascent papilla; the account of the later stages of development of the papilla is tolerably correct. But he observed the later conditions of the abortive embryo-sacs separately, and as independent organs, which he called "peculiar glandular structures" (p. 49 *loc. cit.*), and he argued directly against their being considered as connected with the papilliform structure, closed at its summit, forming the upper free portion of the *archegonium*.

Dr. Wigand contends at great length against the existence of a process of impregnation, but the only fact of importance I find in his arguments is the statement that he found buds (*embryos*) in many cases where no *archegonium* existed on the *prothallia*. This is contrary to my experience, and I feel confident that his investigations were imperfect in this respect. Many pages of *arguments* which he urges against Suminski's views may be passed over, since my own observations, if, as I fully believe them, correct, remove the necessity for discussion, by showing the *facts* to be different. With regard to Dr. Wigand's arguments against the probabilities of the fertilization, I think it unnecessary to enter into them, as the analogous conditions since discovered in the allied groups of the Cryptogamia, especially those recently demonstrated to exist in the Lycopodiaceæ and Rhizocarpeæ, turn the balance of probabilities the other way.

* Zur Entwickelungsgeschichte der Farrenkräuter, von Dr. Albert Wigand. Botanische Zeitung, vol. vii. p. 17 *et seq.* 1849.

Lastly, it is unnecessary to criticise Dr. Wigand's views as to the origin of the *embryo*, or, as he calls it, the "bud" of the new plant, since he admits that he did not trace the earlier stages of its development, and seems never to have investigated it by sections, so as to see the relations with the embryo-sac. His *opinion* was that no relations did exist.

Shortly after the appearance of Dr. Wigand's memoir, M. G. Thuret * published an account of the *antheridia* and their contents, the particulars of which agree pretty closely with those I have given. He states the structure of the *antheridium* to be less simple than Suminski and Wigand had described it, consisting of a parent-cell of the *sperm-cells* surrounded by an annular cell, but not by a collection of flattened cells such as Schacht and Hofmeister describe. He does not enter minutely into the development of the *spermatozoids*, but describes them accurately, excepting, as I believe, in reference to the hyaline vesicle, which he says they *ordinarily* drag about with them; this vesicle, which in a later paper † he states to be in all probability a product of the *spermatozoid*, I consider to be the parent *sperm-cell*, from which the *spermatozoid* has not completely extricated itself, and I did not find it in the majority of cases.

In the same year M. Hofmeister published a brief preliminary summary of his observations on the reproduction of the Cryptogamia ‡, wherein he arrived at conclusions which approximate pretty closely to those I have given, but to which I shall refer more particularly presently, in analysing the portion referring to the Ferns of his great work on this subject.

The next important contribution was an elaborate paper by M. Schacht §. In examining this it is unnecessary to repeat the particulars in which he agrees with all other authors, and I shall therefore confine myself to the debated points.

In reference to the *antheridia*, where he differs from Thuret and myself, he states that the envelope of the parent-cell of the *sperm-cells* is composed of a number of cells, the annular cell which I have described being supposed to be divided by four perpendicular walls, so as to form four cells constituting a quadrangular boundary to the central cell. Where a horizontal septum exists, the envelope would consist of eight cells forming two circles of four. This view I hold to be incorrect, for I never could see the numerous boundary lines which such a structure would exhibit, in the hundreds of *antheridia* which I have examined. He also supposes that the *sperm-cells* originate by free cell-formation in the central cell, which I must distinctly deny.

Schacht describes the *spermatozoids* as having four and a half or five turns in the spiral coil; I believe three to four is the utmost: moreover, he regards the widest convolution as the anterior, a view which I cannot explain, and he states that this passes into a vesicular structure which swells up in water (as described by Thuret); this I consider the *sperm-cell*, still adherent to the *spermatozoid*.

* Note sur les Anthéridies des Fougères, par G. Thuret, Ann. des Sc. Nat., 3rd Ser., Botanique, t. xi. p. 5.

† Ann. des Sc. Nat., 3rd Ser., Botanique, t. xvi. p. 29, 1851.

‡ Ueber die Fruchtbildung und Keimung der höheren Kryptogamen. Botanische Zeitung, vol. vii. p. 793, 1849.

§ Beiträge zur Entwickelungsgeschichte der Farrenkräuter, von Hermann Schacht. Schlechtendahl's Linnæa, xxii. p. 753, 1849.

The *archegonia* are stated by him to be found exclusively upon the thickened part of the *prothallium* (in opposition to Wigand), as I have described them. He further says that the earlier stages of development are difficult to make out, but he believes the papilla originates by the subdivision of one of the cells of the *prothallium* into four by vertical septa crossing each other, these growing out into a conical body; the canal, and the cavity at the base (the *embryo-sac*) are supposed to originate as intercellular cavities, by the separation of the cells bordering them. The canal is closed at first and open afterwards. It is evident from these statements that the earlier conditions of the *embryo-sac* were overlooked. The mucilaginous filaments in the canal of the *archegonium* were seen and figured by Schacht, who correctly asserts that they are not decaying *spermatozoids*, as supposed by Suminski. He states that the embryo originates in the cavity at the base of the *archegonium* (the *embryo-sac*); but he seems to suppose it to be merely a vegetative growth, as is evident from the concluding paragraph of his memoir:—

"Since the 'germ-organ' (*archegonium*) is not open originally, but closed, the fact of its opening subsequently, when it has become surrounded by a high cellular wall, together with the circumstance that the direction of the orifice is downwards, render it scarcely conceivable how 'spiral-filaments' could make their way into it; moreover, in spite of the utmost patience and care, I could never observe a 'spiral-filament' inside the 'germ-organ,' still less the conversion of one of them into the 'germ' (*embryo*). Consequently the impregnation of the Ferns, as described by Count Leszczyc-Suminski, is more than improbable, and thus the inclusion of the Ferns among the *Phanerogamia* is by no means justified."

In these conclusions we see that the bias given by the adherence to Schleiden's doctrine of the origin of the embryo in the *Phanerogamia*, of which Schacht is one of the leading defenders, has prevented his entertaining the idea of the *spermatozoids* exerting simply a fertilizing influence. All his argument is against the conversion of one of them into an *embryo*, so that the hypothesis I have adopted is not touched by the above statement, and it is unnecessary to add further remarks.

In the following year M. Mettenius* published some important researches on this and allied points in the reproduction of the Cryptogamia, in which, however, he confined himself, in regard to the Ferns, to a description of the development of the *archegonia*. In this his statements agree in the essential particulars with those I have given above, since he also believes Suminski to have overlooked the superficial cell covering the *embryo-sac*, and giving origin by its division to the papilla which subsequently grows up. There is only one anatomical point in which I think he was probably in error, namely, in reference to the mode of development of the papilla, the projecting portion of the *archegonium*. He states that the first cell is divided into four by crossing vertical walls, that these four cells grow up equably and become divided by horizontal septa so as to form four parallel columns each composed of four or five cells one above the other, between the contiguous internal angles of which the canal leading down to the *embryo-sac* is formed as an intercellular passage. My observations, as already stated, lead me to believe that the process is somewhat different from this, and that Hofmeister's description is more correct.

* Beiträge zur Botanik, Heft i. Heidelberg, 1850.

In the same year appeared an essay on this subject by Dr. Von Mercklin*, which I have not seen, but I am able to state the principal points in it, from the circumstance of his having published an abstract of them in the 'Linnæa†,' in answer to Schacht's criticism of Suminski's views.

Von Mercklin states that the *antheridia* appeared to him to consist of never more than five cells; sometimes they appeared still more simple, but he gives no details in his abstract. Of the *spermatozoids* he says that the figures given by Thuret and Wigand agree best with his observations, those of Suminski worst, but he regards the large vesicle figured by Schacht at the extremity of the widest coil, as the adherent *sperm-cell.* He also considers the broad convolution to be the posterior, since the *spermatozoid* always advances with the narrow end foremost; in this his statements accord with my own observations.

In reference to the *archegonia*, he truly says that Schacht overlooked the earliest stages, and he asserts that although he is not positive concerning all cases, he has distinctly seen an orifice into the cavity of the *archegonium* (the intercellular cavity, as he and Schacht consider it, but the *embryo-sac* of my description) in the situation of the cell from which the papilla grows up, pretty much therefore what Suminski described. Moreover, he states that he has seen *spermatozoids* enter this. But he does not appear to attribute importance to any particular epoch for the contact of the *spermatozoid* with the *embryonal vesicle*, which lies in the cavity (*embryo-sac*), for he states that of the three times he witnessed this phenomenon, in the course of an entire year's observation of the subject, the *spermatozoids* twice entered the nascent organ, as described by Suminski, and in the other case entered the open canal of a fully developed *archegonium*, to reach the "germ-cell" (*embryonal vesicle*). He states his belief that the mucilaginous filaments seen by Schacht, Mettenius, &c., in the canal, are really altered *spermatozoids*, and he concludes with the following assumptions:—

"1. The *spermatozoids* do regularly enter into the *archegonia*; and, 2. Probably contribute to the origin or the development of the first 'germ-frond.' How this takes place I know not, and the details concerning it, given by Count Suminski, remain for the present unconfirmed."

The last observations to which I have to refer are those contained in M. W. Hofmeister's recent work‡, forming part of an elaborate series of investigations on the reproduction of the higher Cryptogamous plants.

This author, like Schacht, describes the *antheridium* as a more complex structure than I and Thuret imagine it to be, since he believes the walls enveloping the central parent-cell of the *sperm-cells* to consist of four or eight cells, constituting a quadrangular boundary, instead of being simply one or two annular cells. He further states that he found, on young *prothallia* produced by budding from old barren and proliferous *prothallia*, *antheridia* of the

* Beobachtungen an dem Prothallium der Farrenkräuter, von Dr. C. E. von Mercklin. St. Petersburgh, 1850.

† Zu den Untersuchungen über die Entwickelungsgeschichte der Farrenkräuter, von Dr. C. E. von Mercklin. Schlechtendal's Linnæa, xxiii. 723. 1850.

‡ Vergleichende Untersuchungen der Keimung, Entfaltung und Fruchtbildung höherer Kryptogamen, &c. 4to. Leipzig, 1851.

simple structure described by Suminski and Wigand, consisting of a simple cell; this statement is quite contrary to my observations; I frequently examined *antheridia* in all stages in such *prothallia*, and they differed from the normal form only, in certain cases, by being supported on elongated pedicels produced by an unusual growth of their basal cells (fig. 50). With regard to the mode of development of the *sperm-cells*, Hofmeister describes, as I have done, the gradual subdivision of the mucilaginous contents of the parent-cell into numerous cubical portions, each of which becomes clothed with a membrane and produces a *spermatozoid* within it. His description of the *spermatozoids* differs but little from mine; he asserts, however, the regular existence of a long and very slender hair-like process at the hinder extremity, which I have only seen an indication of in one case.

In his account of the development of the *archegonium* he differs considerably both from Mettenius and myself, although the final results are the same. According to him, the papillar process is formed before the basal cavity (the *embryo-sac*), by the growth outwards and subdivision of one of the superficial cells of the cushion-like thickening of the *prothallium*. He describes the formation of the *archegonium* in the following manner: the superficial cell which gives origin to it becomes divided by an oblique wall into an upper and a lower cell, the upper and larger is again divided by an oblique wall inclined in the opposite direction, and this is repeated five or six times; this would result in the formation of a papilla composed of two parallel rows of cells slightly overlapping alternately as they rise; but as they are developed each is divided into two by a perpendicular radial wall, so that the papilla consists of four conjoined vertical piles of cells. In the next place, either all or only the lowest of the cells of one of the vertical rows become divided into two by a tangental wall; so that, in the first case, a central row of cells is formed, running up the centre, or, in the second case, the extra cell is only formed at the bottom. This lowest cell, which is the *embryo-sac*, becomes enlarged rapidly; the cells of the *prothallium* immediately surrounding it become divided by septa so as to form a kind of epithelial layer around it. During this growth the canal is formed up the centre of the papilla, when the fifth row of cells exists by the solution of all but the bottom one, and when this extra cell is formed only at the bottom, by the separation of the contiguous inner angles of the four rows, so as to form an intercellular passage. The greater part of the *archegonia* undergo no further development after this canal opens at the apex, but the membrane bounding the canal and the cavity formed by the basal cell become coloured rich brown.

With regard to this description of the development of the *archegonium*, I believe it to be correct so far as relates to the production of the upper part, namely the papilla, excepting in respect to the formation of the fifth row of cells, subsequently dissolved to leave the canal open. But the mode of origin of the basal cell or *embryo-sac* is certainly contrary to my observations, since I found it before the papilla had begun to be developed, and surrounded at this early epoch by the so-called 'epithelial' layer (figs. 54–57), the papilla being produced by the cell lying outside it.

Hofmeister declares in favour of the entrance of a *spermatozoid* into the canal of the *archegonium*, to fertilize a little spherical cell (the *embryonal vesicle*) originating in the basal cell or *embryo-sac* of the *archegonium*; this cellule then begins to expand and to be

subdivided, so as to form a globular mass of cells, in which the prominences indicating the radicle and leaf soon make their appearance.

He never saw the actual entrance of the *spermatozoid* into the *archegonium*.

VI. Conclusions.

In summing up all these statements it becomes evident that the balance of evidence is in favour of the existence of sexual organs, and of a process of impregnation, giving rise to a new individual, as asserted by Suminski, although under conditions somewhat different from those described by that author. Only two of the observers who have repeated his investigations throw doubt upon these points, namely Wigand and Schacht: the statements of the former as to matters of fact are far from sufficient to bear out the mass of argument he has built upon them against the existence of sexes; in fact, his observations were so imperfect, that he described the two parts of the *archegonium*, the *papilla* and the enlarged *embryo-sac*, as distinct structures, while he never traced the origin of the new plant at all. His observations may therefore be safely passed over. Schacht's are more complete, but he again only *argues* against the probability of a sexual conjunction, with the preconceived notion that this must be analogous to what he erroneously believes to be the conditions in the Phanerogamia; while his observations furnish facts which greatly support the probability of an impregnation by the *spermatozoids*; the difficulties he suggests being of little weight in comparison with those of accounting for the existence of all the peculiar structures by any other hypothesis.

The opinions of all the rest are in favour of the impregnation (Thuret does not treat of the *archegonia*); and the differences between them, except in the case of Suminski, are unimportant in a physiological point of view, merely presenting questions of anatomical and morphological interest. And since Suminski's description of the mode of origin of the embryo would be altogether at variance with what exists, not only in other plants, but also in animals, and is opposed to the observations of all the rest of us (except the doubtful support given by Von Mercklin), I cannot but repeat my belief that he was led away from the facts by his imagination being preoccupied by Schleiden's doctrine of the impregnation of the Phanerogamia.

These observations on the Ferns have acquired vastly increased interest from the subsequent investigations of Hofmeister, Mettenius and Nägeli on the allied Cryptogams, and above all, from Hofmeister's observations on the processes occurring in the impregnation of the Coniferæ *.

Not only have these investigations given us a satisfactory interpretation of the *archegonia* and *antheridia* of the Mosses and Liverworts, but they have made known and coordinated the existence of analogous phenomena in the Equisetaceæ, Lycopodiaceæ and Rhizocarpeæ, and shown, moreover, that the bodies described by Mr. Brown in the Conifers, under the name of 'corpuscles,' are analogous to the *archegonia* of the Cryptogams, so that a link is hereby formed between these groups and the higher flowering plants.

* Vergleichende Untersuchungen, *loc. cit.*

It would be out of place to enter into a detailed examination of these discoveries at the close of this long memoir. They are to be found in the work of Hofmeister * already quoted in regard to the Ferns. I may also refer to a *resumé* of the present state of knowledge on these subjects, published by myself in the 'Annals of Natural History †,' for the facts and general conclusions to be derived from them, and to a Report furnished to the British Association in 1851, for an account of the historical development of these questions during late years.

I cannot conclude without once more directing attention to the many striking analogies recently revealed between the phenomena of reproduction in plants and in animals. They must excite the strongest interest in the minds of all those pursuing the study of biological laws. Many of the facts rest, at present, it is true, upon the authority of but one or two observers, and it can scarcely be doubted that much remains to be discovered before all the details are sufficiently established. The investigation of the reproduction of Ferns is the point which has been most pursued hitherto, and even here there is considerable discrepancy in reference to anatomical conditions. My own observations have satisfied me only after prolonged and careful study of the subject; for where we have to compare successive stages in distinct preparations, and this by means of dissection of microscopic structure, there are very numerous inlets for misconceptions. If I have fallen into errors, I trust they may be soon detected by other observers, whom this memoir may attract to similar researches.

London, May 1852.

DESCRIPTION OF THE PLATES.

Tab. XIV.

[The specimens were in most cases self-sown plants, and moreover were often mingled before examination, so that I am unable to say more than that they belonged principally to an unknown *Adiantum*, an *Asplenium*, *Pteris serrulata*, and *Gymnogramma chrysophylla*. Most of the stages, however, were observed repeatedly in the last species. The drawings were all made in outline with the aid of the camera lucida eye-piece, except in the cases of Figs. 33, 41–47, and 75.]

Figs. 1 & 2. Germinating spores: the second figure exhibits a radical filament.

Figs. 3 & 4. More advanced specimens.

Figs. 5–8. Subsequent stages, in which lateral expansion is going on.

Fig. 9. A young *prothallium*, in which the peculiar obcordate form is already distinguishable.

Fig. 10. Under surface of a young *prothallium* of tolerably complete form, before the thickened cushion has made its appearance in the middle.

Fig. 11. A more highly magnified view of half such a *prothallium*, in which a number of *antheridia* exist (under surface).

Fig. 12. A young *prothallium*, produced by budding from the margin of an old sterile (proliferous) *prothallium* (under surface).

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* See *ante*, page 133.

† June 1852.

Fig. 13. Greatly enlarged view of two cells of a *prothallium*, showing the position and appearance of the green chlorophyll globules.

Fig. 14. Another cell, occurring isolated among others of the ordinary character, in which the large chlorophyll globules have acquired a parenchymatous appearance from mutual pressure.

Fig. 15. Chlorophyll globules very much magnified, exhibiting (starch) granules within, and apparently a membranous coat.

Fig. 16. Magnified fragment of a *prothallium* from the neighbourhood of the anterior notch (under surface), bearing several *antheridia*, some imperfect, one ripe, two effete: the lowest is seen sideways, and the structure is made evident by the brown colour of the membrane of the cavity which has discharged its *spermatozoids*.

Fig. 17. Two cells, from which *antheridia* are being formed, by budding out from the lower faces: the left-hand one is the youngest and contains a little chlorophyll; in the right-hand one the chlorophyll has given place to dense protoplasm.

Fig. 18. Marginal *antheridia*, almost ripe.

Tab. XV.

Fig. 19. *Antheridia* in various stages; the brown one has discharged its *spermatozoids*. *a.* represents a brown peculiar thickening of the cell-walls, with the formation of bars or striæ, occasionally met with in old *prothallia*.

Fig. 20. *Antheridium*, seen by looking down upon it.

Fig. 21. Side view of an *antheridium*, in which the protoplasm is just beginning to subdivide to form the *sperm-cells*.

Fig. 22. A more advanced specimen.

Fig. 23. Nascent *sperm-cells*, from the preceding figure.

Figs. 24–26. *Antheridia*, seen from above, showing the subsequent stages of development of the *sperm-cells*. In figs. 24 & 25 the annular enveloping cell is still perceptible; in fig. 26 its inner membrane is pressed out and applied against the outer one, and invisible.

Figs. 27–29, 31, 32. Various stages of development of marginal *antheridia* from young *prothallia*, produced from buds arising on old sterile *prothallia*.

Fig. 33. Hairs found near the notch on the under face of perfect *prothallia*.

Fig. 34. Side view of an *antheridium* distended with perfect *sperm-cells*.

Fig. 35. *Antheridia*, seen from above, focused to show the condition of the ripe *sperm-cells* within.

Fig. 36. An *antheridium*, burst by pressure, emitting its *sperm-cells*.

Fig. 37. *Sperm-cells*, one with a nucleus, before the spiral filaments or *spermatozoids* are perceptible in them.

Fig. 38. Side view of an *antheridium*, with the *spermatozoids* escaping freely, bursting the *sperm-cells* within the cavity of the *antheridium*.

Fig. 39. *Sperm-cells*, not quite ripe, exhibiting the *spermatozoids* coiled up in them.

Fig. 40. *Spermatozoids* in motion, seen in different positions; the halo of light around each is the result of the movement of the cilia, which is so rapid that they are invisible.

Fig. 41. *Spermatozoids*, arrested by solution of iodine, exhibiting the cilia.

Fig. 42. Peculiar conditions of the *spermatozoids*, seen in one instance only: the left-hand figure represents one uncoiled; the right-hand one appears to have a capillary tail, since it dragged the little mass of mucilage represented along with it.

Figs. 43 & 44. *Spermatozoids*, imperfectly developed and incapable of extricating themselves from the *sperm-cells*, but seen in motion.

Fig. 45. Drawing representing the presumed character of a perfect *spermatozoid*, derived from the examination of numerous specimens.

Fig. 46. Imperfect *spermatozoids*.

Fig. 47. Other forms, where the coils were distinct, but which were sketched while in motion, so that the cilia were not seen.

Fig. 48. Side view of an *antheridium* after it had discharged its *spermatozoids*. The lid is still attached, but the internal membranes have acquired a brown colour.

Fig. 49. Another specimen from which the lid has been wholly detached.

Fig. 50. Portion of a proliferous old *prothallium* with marginal, mostly effete, *antheridia*.

Fig. 51. Slightly magnified view of the under side of a perfect *prothallium*, in which the cushion-like thickening has been developed.

Fig. 52. Magnified view of the region near the notch on the lower surface of a similar *prothallium*, bearing *archegonia* in various stages.

Fig. 53. More enlarged view of a smaller portion with several sterile *archegonia*.

TAB. XVI.

Fig. 54. View of a nascent *archegonium* focused to the (under) surface of the *prothallium*. At *a* is the cell of the general surface overlying the *embryo-sac*, which is seen through, as are the cells bordering it, marked *b*.

Fig. 55. The same preparation focused deeper so as to show the *embryo-sac*, *a*, and its boundary cells, *b*.

Fig. 56. A similar view to fig. 54, where the cell above the *embryo-sac* already exhibits cross lines, indicating its division into three, preparatory to growing out into the papilla; *c* shows the cellule (*embryonal vesicle*), with a nucleus formed in the *embryo-sac*; *b*, the boundary cells.

Fig. 57. The same figure focused deeper: *a*, the *embryo-sac*; *b*, its boundary cells; *c*, the *embryonal vesicle*.

Fig. 58. Lateral views of *archegonia*, showing the gradual development of the papilla.

Fig. 59. More advanced papillæ before the canal is visible.

Fig. 60. Similar papillæ seen from above.

Fig. 61. Lateral view of an *archegonium* in which the canal of the papilla is becoming evident.

Fig. 62. Vertical section through the thickness of the cushion-like mass of the *prothallium*, passing in various situations through *archegonia*.

Fig. 63. Vertical section of two *archegonia*, one of which exhibits the mucilaginous filaments hanging out from the canal.

Fig. 64. Vertical section passing through four *archegonia*; *b*, the cells bounding the *embryo-sac* of one of them.

Figs. 65 & 66. Vertical sections of *archegonia*, passing through the canals and *embryo-sacs*.

Fig. 67. Vertical section of a portion of a prothallium passing through two *archegonia*.

Fig. 68. More highly magnified view of three *archegonia*, differently focused; the side one shows the canal through the transparent walls; the middle displays the *embryo-sac* and *embryonal vesicle* showing through.

Figs. 69 & 70. Views of *archegonia* obtained without sections, focused to show the contents of the canals and *embryo-sacs*, distinguishable through the transparent walls.

Fig. 71. Vertical section passing through two *archegonia*; the left figure appears to be of one just fertilized, the right figure exhibits merely the base of a dead *archegonium*.

Figs. 72 & 74. Views of dead abortive *archegonia*, with the walls of the widely-opened canals and the *embryo-sacs* coloured deep brown.

Fig. 75. Section passing through the *embryo-sac* of an *archegonium* in which cell-development has commenced in the *embryonal vesicle.*

Figs. 76 & 77. Sections showing subsequent stages.

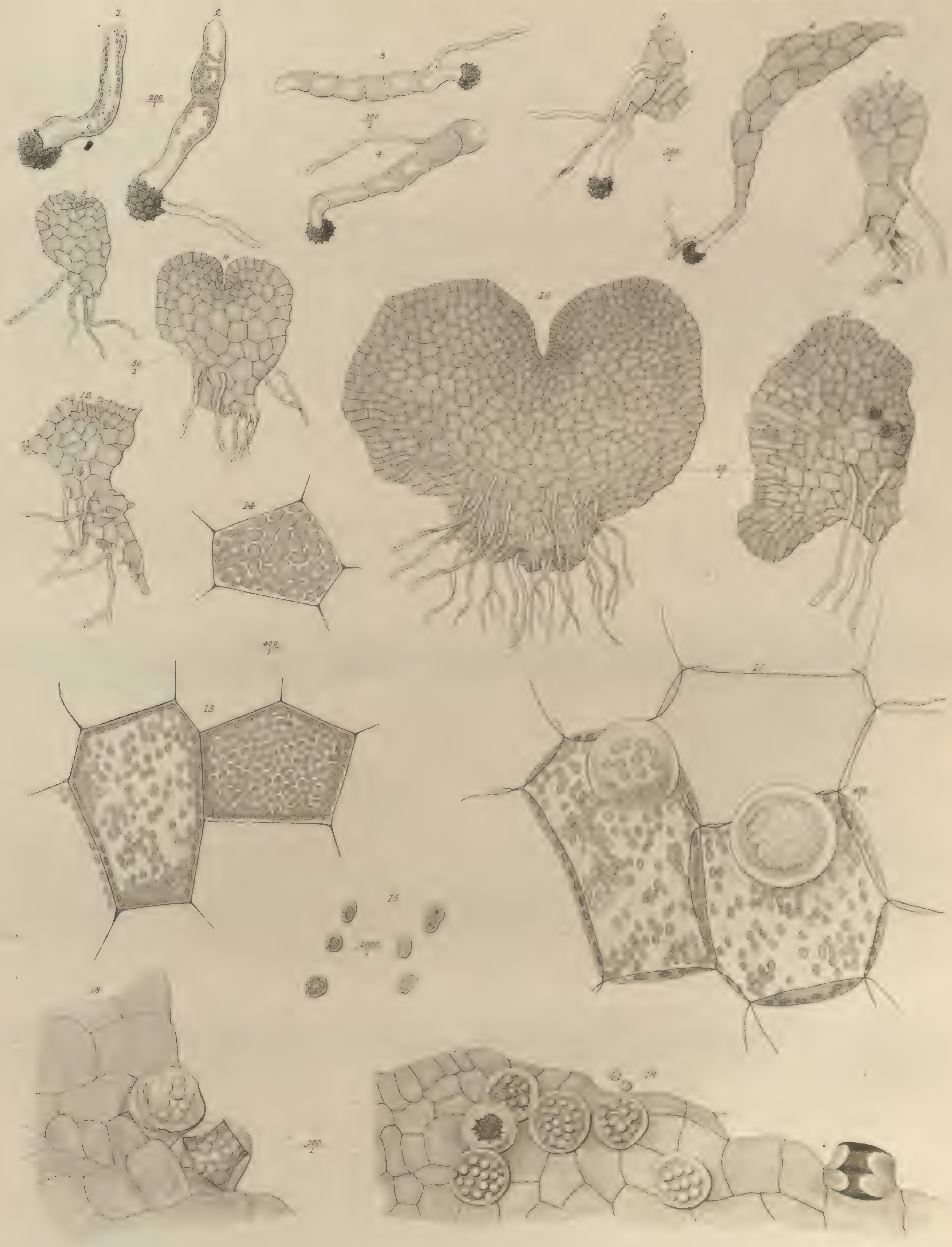
Figs. 78 & 79. Other sections in more advanced stages; in fig. 79 the papilla of the *archegonium* is cut through.

Fig. 80. View of a young plant developed from the *embryonal vesicle.* The cellular mass, *a*, probably the undeveloped radicle, lies loosely in the cavity of the decaying *prothallium*, *d*, *d*, on which the *archegonium* (*g*) is seen; *b* is the first leaf rising towards the notch of the *prothallium*; *c*, the first adventitious rootlet which has broken through at the base *h*; *e* is the second leaflet; *f*, the second adventitious rootlet visible in the interior.

Fig. 81. A young plant making its third leaf; the *prothallium* has here quite decayed off.

Fig. 82. Another young plant making its fourth leaf; *a*, *b* and *c* being the first, second and third.

Fig. 83. A vertical section through the stem of this, removing about one-third of it in front, and showing the nascent vascular system, and the relative positions of the stalks of the leaves *a*, *b* and *c* of the last figure and of the nascent fourth leaf, *d*; between them are seen the brown cellular ramenta.



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XV. *On Two Genera of Plants from Chile.* *By* JOHN MIERS, *Esq., F.R.S, F.L.S. &c.*

Read November 18 and December 2, 1851.

AMONG the few very interesting plants which I was enabled to collect during my rapid journey over the Cordillera in 1825, were the two following, which being yet undescribed, may perhaps claim the attention of the Linnean Society. The first evidently belongs to the tribe of the *Eriogoneæ*, of which a monograph by Mr. Bentham was read before the Society in 1835, and subsequently published in the 17th volume of its Transactions. It differs from all others of the tribe in its habit, for its very slender ramifications are always dichotomously divided in every axil, and its solitary involucre, on a lengthened capillary pedicel, springs from the middle of each bifurcation; it is however easily distinguishable from the rest by the proportion of its floral parts in a manner to be presently noticed. All the *Eriogoneæ* hitherto discovered in South America have been found on the western side of the Andes, and this is probably the first instance known of their occurrence on the eastern declivity.

The learned author of the monograph above quoted, states that he does not agree with Dr. Meissner and M. DeCandolle, who infer the normal number of the stamens in the *Polygonaceæ* to be double that of the lobes of the perigonium, and that in all instances occurring with a less number of stamens, this diminution is alone attributable to the abortion of those parts. Mr. Bentham, on the contrary, shows that this relation is not at all manifest, and he endeavours to prove that the normal number of floral parts is always ternary, the six lobes of the perigonium being biserial, the nine stamens in three series, and the ovarium surmounted by three styles and three stigmata. This arrangement, however, is far from general, for the greater number of genera present only five divisions of the floral envelope, with six, eight or nine stamens. *Atraphaxis*, notwithstanding, offers a binary arrangement of its parts, viz. four lobes in the perianthium in two rows, six stamens with two styles, and two stigmata.

The discrepances here alluded to may, however, be reconciled, if we pay attention to the following circumstances. There does not seem any apparent reason why botanists should have constantly regarded the floral envelopes in the *Polygonaceæ* as a perigonium or perianthium, words intended to express a confluence of calyx and corolla into one common floral covering; but here the parts constituting such envelope manifestly bear the usual characters of a distinct calyx and corolla, for the floral segments are divided to the base, and exhibit their origin externally upon an annular hypogynous ring, that serves to support the stamens as well as the stipitate ovarium: they are always in two or more whorls, are deeply imbricated, the external series being of a somewhat denser texture, and although petaloid, these segments have every claim to be regarded as so many sepals, while the

more internal leaflets bear the usual characters of petals. Were this distinction once admitted, and we were to conclude the normal arrangement to be ternary, and to allow the existence of an occasional binary combination, by the suppression of some of its parts, all the difficulties of its variable structure could be easily explained. In the solitary instance where the floral envelopes are only three (as in *Königia*), we might look upon it as an apetalous genus; where they consist of six lobes, the three outer may be regarded as sepals, and the others as petals; or when nine, the six interior lobes as a double row of petals. In like manner, when five in number, we may conceive the two outer lobes (which in such cases are always more exterior) to be sepals, and the other three to be petals; when four or eight, the same distinction may be made by dividing them into binary series. This hypothesis, though only a modification of Mr. Bentham's, will obviously reduce the number of deviations from the normal rule. There does not indeed appear any reason why the floral envelopes of the *Polygonaceæ* should not be entitled to the same distinction into calyx and corolla, as is admitted, for instance, in the *Polygalaceæ*, where the calyx is often comparatively large and petaloid in texture, or as in the *Portulacaceæ*, where the same occurs, and where the number of sepals (different from that of the petals) is only two, in the same manner as, according to my view, exist in *Polygonum*, *Fagopyrum*, *Coccoloba*, *Ceratogonum*, *Emex* and *Calligonum*, in which last-mentioned genus the two exterior leaflets are larger and marcescent, showing the difference of their nature from the three petals, which remain persistent about the fruit. The same decadence of the sepals and persistence of the corolla occur also in the *Portulacaceæ*. In many other genera of the *Polygonaceæ* with six floral segments, the outer series, which are different in texture, fall away, while the petals remain, investing the achenium. This view of the subject is much confirmed by the argument of Prof. Lindley*, where he offers very cogent reasons for associating the *Polygonaceæ* with the *Caryophyllaceæ* and the *Portulacaceæ*, with which orders they agree in the unsymmetrical inconstancy of their floral parts, in their sepals being often of petaloid texture, in the insertion of their stamens upon a hypogynous ring, quite free from the petals, in their somewhat stipitate ovarium, and in their farinaceous albumen enclosing a curved embryo. The *Caryophyllaceæ* have also their petioles somewhat vaginant.

All the *Eriogoneæ* hitherto known accord with the normal rule, as they present six floral segments in two series, nine stamens and three styles, but in the plant under consideration, we have an unusual deviation from the general disposition, for here we find a quaternary arrangement, the involucre being generally 4-cleft, each flower having eight distinct, very imbricated segments, eight stamens fixed upon the hypogynous support or gynophorus, and four styles and stigmata. In accordance with the views above suggested, I shall therefore consider the four outer segments as a calyx of four sepals, and the inner lobes as a corolla of four petals. I will here remark, that in the same specimen I have observed, though rarely, that some of the involucres contain flowers in which their parts are trimerous, *i. e.* three sepals, three petals, six stamens, three styles and stigmata, but the involucre in such case is still 4-pointed.

* Vegetable Kingdom, p. 50.

In *Chorizema* and *Mucronea*, the involucres are 1-flowered, being 6-toothed in the former and bidentate in the latter; in *Eriogonum* and *Chorizanthe*, the inflorescence is generally terminal, and capitate in *Mucronea*, with three involucres, verticillately arranged in each flowering axil; but this plant, differing from all others, offers only a single stipitate involucre in each axil or dichotomy. From all these peculiarities, I naturally at first concluded it would constitute a new genus, which I proposed to call *Tetraraphis*, closely allied to the *Oxytheca* of Mr. Nuttall, described in the Journal of the Academy of Natural Sciences of Philadelphia (2nd Ser. i. 169). Although agreeing with that description in its similarity of habit, its linear radical leaves, a single few-flowered involucre in each axil, supported on a filiform pedicel, with its teeth armed with long rigid bristles, *Oxytheca* appeared to differ in its ramifications being trichotomous, in having only three sepals and three petals, and these all united in a tube nearly to the summit, in having six stamens, three styles and stigmata, in its achenium being compressed and 2-sided, and in its embryo being placed excentrically in fleshy albumen. These differences appeared sufficiently great to warrant the conclusion that the plant under consideration, though closely allied, was generically distinct from *Oxytheca*, and hence it was desirable to compare it with the Californian plant: this I had the good fortune to meet with in Sir W. Hooker's Herbarium, communicated by Mr. Nuttall himself, as an authenticated specimen of his *Oxytheca dendroidea*. I was greatly surprised, however, to find it so closely resembling my own plant in external appearance, and so like it in dimension, in the dichotomous mode of its growth, in the shape of its leaves, and in the size and aspect of its involucres and flowers, as scarcely to be distinguished from it. In my own specimen, the chief specific difference seemed to consist in the constant dichotomy of its ramifications, which are only divided into three branches at its first basal joint, in the bracts at the division of the stems not being quite divided to the base, its leaves not strongly revolute, the achenium not compressed, 2-sided and lenticular, and its flowers, with rare exceptions, being 4-merous, having their floral envelopes nearly divided to the base. Mr. Nuttall, in his generic character, states that the flowers are either diœcious or monœcious, that in the female flowers the perianth is closed to the summit and 6-toothed, that in the male and hermaphrodite flowers it is shortly 6-cleft, and he hesitatingly gives the number of stamens to be six; it must be remembered, however, that his examination was from dried specimens of plants collected by Dr. Gamble in the Rocky Mountains. As Mr. Nuttall includes in his genus *Oxytheca*, another section under the name of *Gomphotheca*, founded upon a very distinct plant, with diœcious pentamerous flowers, possessing a very different habit; as he nowhere states that the two other more legitimate species have monœcious flowers; as I have not noticed the flowers of the plant from the Chilean Andes to be otherwise than perfectly hermaphrodite; and as the floral characters of the Californian plants appear doubtfully stated, or made to include two distinct groups, and at variance in many particulars with the features I have observed,—I feel induced to remodel the generic features of *Oxytheca* in the following manner, in accordance with the facts I have carefully noticed in my own plant, modified in some degree by the circumstances stated by Mr. Nuttall.

Oxytheca, Nutt.

Involucrum 3–4 florum, tubulosum, sub-4-gonum, ad medium 4-partitum; laciniis subæqualibus, acutis, longissimè aristatis. *Flores* hermaphroditi, pedicellati, bracteati, subexserti, demùm cernui. *Sepala* 3–4, petaloidea, æqualia, oblonga, unguiculata, valdè imbricata, imâ basi cum petalis subcoalita. *Petala* 3–4, sepalis alterna et subsimilia, tenuiora, glabra, imbricata, et cum istis persistentia. *Stamina* 6–8, e summo gynophoro orta, inclusa, 3–4 alternatim breviora, sepalis opposita; *filamenta* filiformia, apice inflexa; *antheræ* rotundatæ, cordatæ, dorsifixæ. *Ovarium* ovatum, 3–4-gonum, stipitatum, petalis tertiò brevius, 1-loculare; *ovulo* basilari, erecto. *Styli* 3–4, breves, erecti, demùm divaricati; *stigmata* capitata. *Achenium* monospermum, ovale, 3–4-costatum, subcompressum, sepalis petalisque emarcidis arctè tectum. *Semen* unicum, loculum implens; *testa* membranacea. *Embryo* spiralis, antitropus, intra albumen farinaceum inclusus; *cotyledonibus* cochleato-rotundis, foliaceis, accumbentibus; *radiculâ* istis 3-plo longiore, tereti-subulatâ, hemicyclicâ, apice recto verticem spectante.

Herbæ *suffruticulosæ Californicæ et Chilenses, Andicolæ, sesquipalmares, valdè ramosæ,* ramis *gracilibus, in quâque axillâ dichotomè divisis*; folia radicalia *congesta, lineari-subulata,* caulina *bracteiformia, axillaria, terna, basi connata, hinc breviter vaginantia*; involucrum *longè pedunculatum e quâque dichotomiâ ortum*; flores *minuti, sigillatim præcociores*; pedicelli *singulatim basi* bracteâ *lineari aristatâ breviore donati.*

1. Oxytheca spiculata, n. sp.; valdè ramosa, ramulis divaricatis dichotomè deliquescentibus teretibus gracilibus glanduloso-pilosis, foliis radicalibus congestis spathulato-linearibus utrinque aspero-pilosis pilis patentibus è tuberculis totidem ortis; caulinis in quâque dichotomiâ ternis bracteiformibus acutis apice mucronulatis aspero-pilosis basi in vaginam brevissimam confluentibus, pedunculo solitario gracillimè elongato, involucro 3–4-floro; laciniis longissimè aristatis, pedicellis unifloris basi bracteatis demùm exsertis, floribus cernuis 4-meris rarissimè 3-meris, sepalis hirsutulis petalisque consimilibus glabris rubentibus.

Hab. in Andibus Chilensibus, descensu orientali, circa rivulum Sanctæ Mariæ, altitudine 8000 ped. *v.v.*

This plant, about 4 or 5 inches high, is very dichotomously branched. A rosulate cluster of about twenty radical leaves spring from the collar of a lengthened tap-root. The leaves, linear, spathulate and attenuated into a slender petiole, are about 8 lines long, 1 line broad, somewhat fleshy, opake, and are covered on each side with numerous patent rigid hairs, each hair springing out of a prominent tubercle. A simple short terete stem, 8 lines in length, rises out of the cluster of leaves, and is crowned at its summit by a verticil of six acute bracts, vaginantly united at their base: out of this verticil spring three equal branches, 11 lines long, each being in succession and with regularity dichotomously divided into other more slender branchlets, and their nodes, about 10 lines distant, are each furnished at their base with three bracts, two being opposite the stems and one lateral, all equal, acute, aristate, and united into a vaginant cup about each axil: from the middle of each of the first and of each successive dichotomy rises a capillary erect peduncle, 4 lines long, bearing at its summit an urceolate involucre, the tube of which is $\frac{3}{8}$ths of a line long, its four lobes of similar length, each terminated by a fine needle-shaped spine $\frac{3}{4}$ of a line long. The floral bracts are about half the length of the tube which conceals them, and are equal in number to the pedicels, which are smooth, and, when fully grown, $\frac{3}{4}$ of a line long, each bearing a flower $\frac{1}{2}$ of a line in length. The seed enclosed in the

marcescent but persistent floral envelopes is about ½ of a line long. The branchlets and peduncles are sparsely beset with very short patent hairs, bearing a resinous gland at their summit; these are different from the hairs of the leaves, bracts and calyx, which are simple, pointed, and spring out of elevated tubercles.

I found this plant, of which I was only able to collect a single specimen, in January 1825, in the main valley, on the eastern side of the great Cordillera, upon the road leading from Mendoza to Aconcagua, at a spot near the Estero de Santa Maria, which falls into the river Tunuyan, about three leagues above the Punta de las Vacas.

The second plant I have to record is a nearly aphyllous shrub, with straight, erect, virgate branches, terminating in spines, and evidently belongs to the *Bignoniaceæ*, although in many points it varies from the usual structure of that Order. In that family the ovarium, formed constantly of two carpels, is generally bilocular, with ovules commonly ascending or horizontal, attached to the margins of the dissepiment: its fruit is usually a long capsule, more or less woody, 2- or spuriously 4-celled; the seeds are numerous, generally winged, always much compressed, and their exalbuminous embryo presents broad foliaceous cotyledons, cordate at both extremities. In the present instance the ovarium is simply bilocular, with a few ovules suspended on the two faces of the thin dissepiment; the fruit is a small oval drupe, containing a single osseous indehiscent nut, which is 1-celled by abortion, and contains only a single pendulous seed that entirely fills the cavity: this is therefore quite apterous, oval, with a small thick superior radicle, and two plano-convex fleshy cotyledons, a structure quite anomalous in the Order.

I found this plant in the year 1825, upon the skirts of the eastern declivity of the Cordillera, near Mendoza, on the margin of the desert tract called "La Travesia," where it was also found by Dr. Gillies. I have proposed for it the generic name of *Oxycladus*, from ὀξὺς, *acutus*, and κλάδος, *ramus*, in reference to its spiny habit.

It is evident, from the facts just stated, that this genus does not conform with any of the characters that mark the tribes into which the Order has been divided by botanists. The genera that most nearly approach it in habit are the *Catophractes* of Don, figured in the 18th volume of the Society's Transactions, plate 22, and the *Rhigozum* of Dr. Burchell, both of which are spinose shrubs from South Africa; but these have both large yellow flowers, and the seeds of the latter agree with the characters of the true *Bignonieæ*. It will therefore be necessary to place *Oxycladus* in a distinct tribe, and the Order may hence be divided into the following sections.

Tribe 1. BIGNONIEÆ. Capsule dehiscent, 2-celled, 2-valved, with numerous winged compressed seeds attached to both sides of the dissepiment; embryo with flattened foliaceous cotyledons.

Tribe 2. CRESCENTIEÆ. Fruit drupaceous, woody, 2- or many-celled, with numerous winged or compressed seeds; embryo with compressed fleshy cotyledons.

Tribe 3. OXYCLADEÆ. Fruit drupaceous, containing a single 1-celled, osseous, indehiscent nut, with a solitary suspended, rounded seed; the embryo having a superior radicle, with large and nearly hemispherical fleshy cotyledons.

The generic features of this genus may be thus characterized:—

OXYCLADUS, gen. nov.

Calyx gamophyllus, 5-dentatus, persistens. *Corolla* gamopetala; tubo cylindrico, calyce 2–3-plove longiore, vix gibbo, limbo brevi, 5-lobo, sub-bilabiato lobis rotundatis; labio inferiori 3-lobo, lobis paululò majoribus; superiori 2-lobo, in æstivatione imbricativâ semper exteriori. *Stamina* 5, corollæ lobis alterna, quorum 4 didynama, et quinto superiori brevissimo ananthero, 2 inferioribus longioribus faucem attingentibus, 2 lateralibus istis tertio brevioribus; *filamenta* paullo supra basin tubi inserta, filiformia, glabra; *antheræ* rotundatæ, reniformes, cordatæ, 2-lobæ, connectivo dorsali cordiformi adnatæ et huic in medio loborum præfixæ, lobis ovalibus divaricatis anticè longitudinaliter dehiscentibus. *Ovarium* oblongum, pilosum, glandulâ annulari brevi 5-lobâ glabrâ cinctum, 2-loculare; *ovula* in utroque loculo circiter 6, supernè per paria collateralia, e dissepimenti nervo longitudinali seriatim appensa. *Fructus* sub-baccatus, calyce immutato clausus. *Nux* ovatus, acutus, 4-sulcatus, apice 4-denticulatus, 1-locularis, monospermus; *semen* loculo conforme, latere superiori funiculo brevi appensum; *testa* chartacea, favoso-reticulata; *endopleura* membranacea. *Embryo* exalbuminosus; *radiculâ* superiori crassâ, apice mammillæformi; *cotyledonibus* istâ 3-plo longioribus, ovatis, plano-convexis, valdè crassis.

Arbuscula *Mendozensis vix aphylla, spinosa, ramosissima, glaberrima, ramis nitidis, erectis; flores pauci, aggregati, parvuli; corolla cærulescens.*

1. OXYCLADUS APHYLLUS; ramulis erectis virgatis teretibus nitidis rubentibus spinâ terminatis; junioribus oppositis spinæformibus floriferis, foliis bracteiformibus minimis sub flores aggregatis (an bracteis?) linearibus glabris incurvis, floribus 2–3 fasciculatis breviter pedunculatis, calyce glabro, corollâ extùs pubescente pilis recurvis cærulescente, ovario piloso.

Hab. prope Mendozam ad pedum Andium. Vernac. *Ala.* *v.v.*

This is a shrub about 8 feet high, with the habit of a woody leafless broom. The branches have a very smooth bark, of a chestnut-brown colour, almost polished, and the young branchlets that bear the flowers look like spines, being subulate and mucronate, as are also the ends of all the branches: the axils are opposite, but frequently one branch, or both, are barren, which adds more to its spinescent appearance. About two or three flowers spring out of each axil on the spine-like branchlets, bearing at the foot of the peduncles several minute, curved, smooth, linear leaflets, about half a line in length. The peduncles are about a line long; the smooth tubular calyx, crowned with five somewhat unequal, short, triangular teeth, is 3 lines in length; the corolla is tubular, of a bluish colour, and about 6 lines long; the tube is little more than a line in diameter, is pubescent outside, with reflected hairs; it has a bilabiate border formed of five short rounded lobes, which are somewhat expanded and thrown back; the attachment of the filaments at their apex is upon the anterior face of the anthers, and on the connective between the two divaricating lobes, contrary to the general rule of the Order. The fruit is a subfleshy pubescent drupe, enclosed in the persistent and scarcely enlarged calyx, and it contains an oval osseous nut, 3 lines long, 2 lines in diameter, pointed, 4-grooved, and surmounted by four minute teeth; a single seed fills its cavity, suspended by a short thread from the dissepiment, which is pressed against one side of the cell, and upon which may still be seen the abortive ovules; the embryo is exalbuminous, with an obtuse superior radicle,

terminated by a small, dark-coloured mammilla; the cotyledons are thick and fleshy, four times the length of the radicle, and of equal diameter.

EXPLANATION OF THE PLATES.

Tab. XVII.

Fig. 1. *Oxytheca spiculata*: natural size.
Fig. 2. An involucre with a portion of its peduncle, showing the flowers exserted.
Fig. 3. The same, cut open to show the insertion of the pedicels and bracts.
Fig. 4. A young flower-bud with its pedicel and bract.
Fig. 5. A bract seen before and behind.
Fig. 6. A flower with a portion of its pedicel.
Fig. 7. The same, with the sepals thrown back to show the petals.
Fig. 8. The same, with the sepals and petals removed, exhibiting the stamens inserted upon the gynophorus.
Fig. 9. An anther seen in front.
Fig. 10. The same, seen from behind, showing how the filaments are attached.
Fig. 11. The pistil upon its stipitate gland or gynophorus, with the stamens removed.
Fig. 12. The same, with the styles become reflexed.
Fig. 13. A longitudinal section of the same, showing the erect ovule.
Fig. 14. The achenium enclosed in the persistent and withered floral envelopes.
Fig. 15. The same, with the floral covering removed.
Fig. 16. The seed.
Fig. 17. A longitudinal section of the seed, showing the embryo enclosed in its albumen.
Fig. 18. The embryo extracted.

N.B. Figs. 2, 3, 4 & 5 are magnified on the same proportion.
Figs. 6, 7, 8 & 12 to 18 are more highly magnified upon one equal scale.

Tab. XVIII.

Fig. 1. *Oxycladus aphyllus*.
Fig. 2. A flower, showing the mode of æstivation of the corolla.
Fig. 3. The same, expanded.
Fig. 4. A corolla, cut open to show the stamens.
Fig. 5. An anther, viewed in front; showing the insertion of the filament upon the anterior side of the connective, and the pollen-cells in the act of dehiscence.
Fig. 6. The same, seen from behind.
Fig. 7. The same, after dehiscence.
Fig. 8. The pistil, seated upon its hypogynous gland within the calyx, which is cut open and folded back, to show its unequal teeth.
Fig. 9. The stigma, seen in front.
Fig. 10. The same, shown edgeways.
Fig. 11. The ovarium, seated upon its hypogynous glandular cup.

Fig. 12. A vertical section of the ovarium, across the dissepiment; showing the mode of attachment of the ovules.

Fig. 13. The drupe, enclosed in the persistent calyx.

Fig. 14. The same:—magnified.

Fig. 15. The same, with the calyx removed.

Fig. 16. The nut.

Fig. 17. A vertical section of the nut.

Fig. 18. The seed, with its testa and podosperm.

Fig. 19. The embryo, extracted.

N.B. Figs. 1, 2, 3 & 13 are of the natural size.
Figs. 4, 8, 11, 12 & 14 to 19 are magnified.
Figs. 5, 6, 7, 9 & 10 are more highly magnified.

J Miers Esq del. G Jarman sc

Trans. Linn. Soc. Vol. XXI, p.148, t.18.

J. Miers Esq. del.

G. Jarman sc.

XVI. *On Two New Genera of* Fungi. *By the Rev.* M. J. Berkeley, *M.A., F.L.S. &c.*

Read June 1, 1852.

THE illustrious mycologist, Elias Fries, on more than one occasion, expresses the far greater pleasure that he has experienced in ascertaining with complete certainty a single synonym of the earlier writers on Fungi, than in discovering many new species; a sentiment which will meet a responsive echo in the approbation of most true lovers of science. There is indeed a great satisfaction in clearing up a point hitherto obscure; in finding that the pioneers of science, with all their disadvantages, were so far correct in their observations, and therefore worthy of trust in other particulars; the very subjects too are often interesting in an historical point of view; and not only so, but there is often much valuable information to be derived from their mode of regarding matters respecting which, for the most part, no scientific theories or prejudices existed, whatever other analogous drawbacks there might be, insomuch that on many points really juster views were entertained than by many of their successors. Such works as those of Micheli and Schmidel will repay the most attentive study, and many a circumstance has from time to time been brought forward as a new and important discovery, which they and others of their contemporaries had already accurately observed; while, on the other hand, from a careless inspection of their figures without due attention to the context, they have been made to vouch for facts respecting which they had no knowledge. To take a single instance in that branch of botany to which attention is more particularly called in the present memoir, and to which it is proposed to add two new genera, either founded on forms observed and described by the older botanists, or illustrated by matter furnished by them, but not recognized by more modern writers on the subject, the true structure of the hymenium of Agarics is accurately represented by Müller in *Agaricus comatus*, in an early figure of the 'Flora Danica,' whereas the figure in which Micheli is supposed to have represented that structure is meant to express something quite different, the simple circumstance of the quaternate disposition of the spores in Agarics being the only correlative fact known to that author, as appears from his text, which is usually too positive and luminous to admit of much question.

The objects to which the attention of the Society is now drawn are closely related to two which are figured, the one by Battarra and the other by Bulliard, though it should seem not absolutely identical. The first noticed shall be that which calls to mind a figure in the well-known work of the Italian botanist on the Fungi growing in the neighbourhood of Arimini, a work remarkable for its excellent illustrations and general faithfulness, and which may frequently be consulted with profit at the present day. The first edition of this work appeared in 1755, and a second edition was published in 1759, without however any alteration in the matter.

In the fortieth table a figure is given of a *Phallus* which has puzzled all succeeding botanists. Paulet copies it indeed in his large treatise on Fungi, colouring it after the description, and proposing it as a true figure of *Phallus caninus*, Hudson, to which however it bears at first sight but a remote resemblance. Fries says of it, under *Phallus caninus*, "Phallus exilis Marattæ, Batt. Arim. p. 76. t. XL. F. nisi præcedentis icon erronea affinis species*." It seems, however, judging from the other figures contained in the volume, impossible that he should have gone out of his way to make anything so unlike the ordinary form of fungus in question. The account besides is too circumstantial to admit of much doubt. The fungus, Battarra informs us, was found by Father Maratta in the neighbourhood of Rome (ultra Genzanum), on the 5th of October, 1736, in a wood known by the name of Li Disertini, and communicated to the author in May 1754. Several specimens were found in a heap of rotten leaves. The volva is described as dirty white, coriaceous, and filled with a mucilaginous substance as in other species of *Phallus*. From this arose a club-shaped cellular receptacle, hollow within, the upper part being even and solid within (meaning probably that it was imperforate), and covered with a crust which was red when the fungus was young, but when it had arrived at maturity, the top was green, with a zone of red beneath it, the lower portion of the stem being dirty white, sprinkled with reddish brown superficial specks. When the fungus was passed maturity, the upper portion passed into a fœtid fluid.

It should seem then that Battarra did not indeed see the fungus when fresh, and that his figure was taken from a dried specimen, for he says nothing of any drawing; but it is very difficult to conceive how a fungus tapering to a point, as exhibited in Sowerby's figure of *Phallus caninus*, could by any mode of drying assume the broadly clavate form exhibited by the figure.

A fungus, however, has been lately found by H. W. Ravenel, Esq., near the Santee River, South Carolina, which exhibits the peculiar form of that of Battarra, and when forwarded to me by the Rev. M. A. Curtis, was noticed as differing greatly in structure from other species of *Phallus*, in its not showing the slightest distinction between the stem and hymenium. It is true that at a later period specimens of the same species were found by Mr. Ravenel exhibiting the same form as that of *Phallus caninus*, but with the ample hymenium more clearly confluent with the stem, which differs but slightly from it in appearance and structure, and always perforated at the apex, while the loose cellular pale stem of *Phallus caninus*, at the first glance, is distinct from the short and more minutely cellular head. Excellent specimens of both, preserved in spirits, enable me to speak with the greater confidence, though my first observations were founded on the dried specimens only. As then two forms so widely different occur in a species analogous to *Phallus caninus*, though not identical with it, it is very possible that a clavate form of *Phallus caninus* may also exist, and that Battarra's figure is due to such a variety. This would be pretty well established if it were positively clear that the head in Maratta's plant is imperforate, but as he used the word 'perforate' in the description of other species, he would scarcely have omitted it in the present instance, and the phrase alluded to above may therefore be considered as intended to indicate something different from the more common

* Two misprints in the above citation are corrected.

species of *Phallus*. We may, therefore, taking both the European and American species together, conclude, with tolerable certainty, that after all the figure of Battarra does indeed represent a peculiar state of the well-known species. No doubt whatever rests on the mind of Mr. Ravenel as to the identity of the clavate and more fusiform individuals of his plant, though, before ample materials had been collected, he had formed a different opinion.

Having, as far as the materials which have been collected permit, cleared up the very obscure plant of Battarra, I shall now advert more especially to that from South Carolina, which differs from *Phallus caninus*, not only in colour and a more compact texture, but in the important point of having the receptacle perforated.

In *Phallus caninus* the cells of the head are horizontal, compact, much smaller and quite different from those of the stem; in the new fungus, the cells of the head differ little in size, and are more numerous and not arranged horizontally. Though much stress cannot be laid on the clavate form of certain individuals, the structure, taken in conjunction with the perforated pileus, completely justifies the proposition of a new genus for its reception, unless such genera as *Dictyophora*, *Mutinus*, *Dictyophallus*, &c. are to be rejected as mere members of the genus *Phallus*. Indeed, though Fries does not consider *Dictyophora*, so remarkable for its beautiful reticulated veil-like appendage, as separable from *Phallus*, he has proposed a distinct genus, *Mutinus* (formerly *Cynophallus*), for the reception of *Phallus caninus*, in his 'Summa Vegetabilium Scandinaviæ.' On the same principles our plant must be generically distinct. The genus then may be characterized as follows:—

Gen. Corynites, Berkeley et Curtis.

Uterus rotundatus è membranâ duplici gelatinâ distentâ compositus, lobato-rumpens. *Receptaculum* cum stipite elongato celluloso-cribroso omninò continuum, obtusum, perforatum, massâ sporiferâ primùm sinuato-cellulosâ tenaci, mox vero diffluente, tectum. *Sporæ* minutæ.

Fungi *terrestres, oblongi, subfusiformes, autumnales. Genus à* Mutino, *Fries, differt receptaculo minùs discreto, apice perforato.*

C. Ravenelii, n. sp.

On sandy ground, in grassy places. Autumn. Santee River. *Curtis*, Nos. 2573, 3037. *Ravenel*, No. 844.

Egg globose, $\frac{3}{4}$ of an inch in diameter. Volva bursting in two or three lobes closely applied to the stem. Stem $1\frac{1}{2}$–2 inches high, 4–5 lines thick, bright red, coarsely cribrose, attenuated below, above confluent with the receptacle, which is sometimes broadly clavate, sometimes conical, but always more or less obtuse, pervious at the apex, sometimes half as long as the stem. Mass of spores dark olive, soon washed off. Odour heavy and nauseous, but only perceptible when the hymenium is brought near to the nose.

Extreme forms are very different; some specimens approaching to the more ordinary form of *Mutinus caninus*, while others exactly resemble what is figured by Battarra.

The second subject to which I beg leave to call the attention of the Society, is to a group of fungi, of which *Sphærocarpus capsulifer*, Bulliard, is evidently the type. Though the description and figures are far from superficial, they appear for the most part to have been neglected by authors. As far as I have been able to discover, there are no notices of

the species, except by French botanists, and these appear to be for the most part mere compilations from Bulliard. DeCandolle's account, for instance, in the second volume of the 'Flore Française,' is only a transcript, as is also that of Chevallier; who adds to what DeCandolle says the circumstance mentioned by Bulliard, that when the fructifying mass is placed in water, the spores separate from one another as if they proceeded from a capsule, a circumstance which I have observed in one of the species, though not in the two which most nearly resemble the plant of Bulliard.

Duby next gives the characters of a supposed *Physarum*, under the name of *P.? capsuliferum*, but as he describes the flocci as black, his plant cannot be the species of Bulliard; and his remark that Desmazières, who published *Didymium cinereum* at No. 272 of his 'Plantes Cryptogames du Nord de France,' thinks it may possibly be the same with that species, is conclusive as to the point, even though Bulliard has referred to Batsch's figure as a synonym of his *Sphærocarpus capsulifer*.

These are all the notices I can find of this species. It is not in the General Index to Fries' 'Systema Mycologicum,' nor do I observe any notice of it in the text of his work, where so singular a production might have been expected to claim observation. Fries, indeed, in his general remarks, says that conglobated spores are described in several Myxogastres, but that such states are, according to his observations, always abnormal; which may be the reason why he has not noticed the species of Bulliard.

That the spores are, however, essentially conglobated in the species under consideration, and do not form mere accidental clusters, arising from inequable distribution of moisture amongst the mass, or from any other mechanical cause, is most evident under the microscope, the external spores being indeed always attached to a larger body in the centre, so that, when they are quite disunited, the size is seen to vary considerably; and in one species, where they are evidently echinulate, the little points are confined to those portions which were exposed after the fashion of the achænia in *Rhagadiolus edulis*; besides which, in an early stage of growth they are contained in a common sac. There is no doubt that several other *Physara* will be found to possess the same structure, and possibly all those species which have laminæ rather than flocci; and now that attention has been called to the subject, other instances may be found in other genera affording solid grounds for future division. The species which are now generically combined, with one exception of a *Didymioid* aspect, not only agree in structure, but in habit; the main distinction, indeed, besides differences of brightness of colour, consisting in minute variations in the spores. To Dr. Badham the credit of calling attention to Bulliard's figure, and ascertaining the structure, is entirely due, and I have therefore dedicated the genus to him, in the hope that its characters are so well founded as to ensure permanence, a very main point in such compliments.

Externally the fungi in question, with one exception, have the appearance of species of the genus *Physarum*, the peridium being single and smooth, and the spores mixed with flocci. These latter are broad and lamelliform in parts, but vary greatly in breadth, and intermixed with spores, as in other Myxogastres; but these spores grow in little aciniform masses, instead of being single, as in other allied fungi, with the exception of *Enerthenema*, *Reticularia* and *Ptychogaster*; in the former of which, figured by Mr. Bowman

in our Transactions, I have ascertained, as also in the present case, that they are produced within a vesicle, as in *Hymenogaster vulgaris*, Tulasne; thus confirming at once Mr. Bowman's curious genus, and M. Tulasne's observation of a similar anomaly in a different group of fungi; and in the two other genera they form little radiating fascicles. The figures prepared by Corda for his sixth fasciculus, of which, before his ill-fated voyage, he kindly sent me a copy, illustrate this admirably in the case of *Reticularia maxima* and *argentea*. *Tripotrichia*, Corda, has at first sight some resemblance, but the spores have short pedicels, which seems decisive as to their not being conglobated. The genus may be characterized as follows:—

BADHAMIA, n. g.

Peridium simplex, extùs nudum, vel rarissimè subtomentosum, apice demùm lacerato apertum; flocci laxè reticulati, parietibus affixi, hic illic expansi in laminam sæpè triangularem peridio similem; sporæ globosæ vel subangulares, primum sacco communi inclusæ, demum liberatæ, conglobato-adnatæ.

Fungi minores, fragilissimi, muscos vel corticem colentes, Physarum *ut plurimum referentes.*

1. *Badhamia hyalina=Physarum hyalinum*, Auct.

2. *Badhamia utricularis=Physarum utriculare*, Auct.

3. BADHAMIA CAPSULIFER; peridiis sessilibus vel breviter membranaceo-pedicellatis obovatis congestis e nigrocæsiis albidis, floccis candidis.

Sphærocarpus capsulifer, Bull. t. 470. fig. 2.

Trichia capsulifera, DeC. Fl. Fr. vol. ii. p. 254. 1815.

Physarum capsuliferum, Chev. Par. vol. i. p. 339. 1826? Duby, Bot. Gall. p. 861. 1830.

On moss. France.

This species differs from the two following in its spurious stem, more obovate peridia, and white flocci. It is probably most nearly related to *B. utricularis*.

4. BADHAMIA NITENS; peridiis sessilibus depressis congestis nitidè flavis, floccis flavis, sporis extùs fortiter echinulatis.

On decayed oak branches. February 21, 1851. East Bergholt, Suffolk (*Rev. Dr. Badham*).

Forming little crowded orbicular patches, consisting of depressed sublentiform peridia of a bright persistent yellow, perfectly sessile, at length bursting above and dispersing their dark spores, so as to form a border resembling the stains produced by the sporidia of *Sphæria inquinans*. Flocci yellow, broad. Spores at first contained in a common vesicle, which bursts or is absorbed and exposes them in the form of little globose branches, which are often supported by an articulated thread, strongly echinulate, externally smooth towards the common axis. Mother-cells $\frac{1}{1000}$–$\frac{1}{600}$ of an inch in diameter; spores $\frac{1}{2300}$–$\frac{1}{2000}$.

5. BADHAMIA PALLIDA; peridiis sessilibus depressis sublentiformibus hic illic congestis sparsisque pallido-luteis, floccis flavis, sporis majoribus granulatis: vesiculâ centrali magnâ.

On decayed oak branches. March 1, 1851. East Bergholt, Suffolk (*Rev. Dr. Badham*).

At first exhibiting more or less effused cream-coloured patches, which gradually assume a yellow tinge, and from which arise a few irregular groups of yellow depressed peridia, some of which are confluent, somewhat wrinkled. Flocci evidently continued from the peridium and of the same colour,

branched, forming triangular spaces at the origin of the branches. Mother-cells $\frac{1}{600}$–$\frac{1}{500}$ of an inch in diameter. Spores slightly granulated, $\frac{1}{2000}$–$\frac{1}{1750}$ of an inch long, attached to a large central vesicle. The peridium consists of a membrane, rough with very minute granules, which become more dense where the flocci are produced. In old specimens the patches assume an olive tinge.

6. BADHAMIA FULVELLA; peridiis gregariis sessilibus globosis nigris tomento subtili fulvo vestitis, floccis albidis.

On dead wood. East Bergholt, Suffolk (*Rev. Dr. Badham*).

Peridium very thin, black apparently, but yellow when divested of the spores. Gregarious, but not forming distinct patches, sessile, globose, clothed with very delicate tawny down. Mother-cells $\frac{1}{1000}$ of an inch in diameter; spores $\frac{1}{2000}$–$\frac{1}{2500}$, black, forming a compact mass. Flocci often swollen in the middle, whitish.

The habit is that of a *Didymium* rather than of a *Physarum*.

EXPLANATION OF THE PLATE.

Fig. 1. *a. Badhamia nitens*:—nat. size. *b.* Separate peridia:—slightly magnified. *c.* Mother-cell, with young spores. *d.* Groups of spores. *e.* Spores, showing the external echinulate portion:—all more or less magnified.

Fig. 2. *Badhamia pallida*:—nat. size. *b.* Separate peridia:—slightly magnified. *c.* Portion of peridium. *d.* Flocci. *e.* Groups of spores, showing the large central cells, which are often pyriform:—more or less magnified.

Fig. 3. Spores of *Badhamia hyalina*:—magnified.

Fig. 4. *Corynites Ravenelii*, in various states.

Trans. Linn. Soc. Vol. XXI. t. 19. p. 184

Rev. M. J. Berkeley del.

G. Jarman sc.

XVII. *On the Habits and Structure of the Great Bustard* (Otis tarda *of Linnæus*).

By WILLIAM YARRELL, *Esq., V.P. and Treas. Linn. Soc. &c.*

Read January 18, 1853.

SOME kind friends having supplied me with various particulars relating to the habits of the Great Bustard (*Otis tarda* of Linnæus), most of which, as far as I am aware, have not been made public, I have endeavoured to put these materials together, in the belief that they might be found sufficiently interesting to be communicated at a meeting of the Linnean Society; the great scarcity, or rather, the now rare occurrence of the bird in this country, affording but few opportunities for observation.

The first communication came from C. A. Nicholson, Esq., of Balrath Kells, in the county of Meath, and was as follows:—

"You will perhaps be interested by the following few remarks on the habits of the Great Bustard, as observed by me in the neighbourhood of Seville, where they exist in large numbers.

"The males begin to arrive in the cultivated part of the country at the beginning of February; they come in flocks, varying from seven to fifty-three, the smallest and largest numbers I have seen together at that season of the year. The old birds always go together; those of a year old, which are much smaller, never mix with them. The young birds have neither beard nor pouch.

"The females do not arrive till the beginning of April, and come singly, or at most in pairs: as soon as they arrive the flocks of males begin to break up, and after about three weeks you seldom meet more than three or four old males together, they being very frequently to be met with singly. At this time, on a fine day, they spread their tails like Turkey cocks, drooping their wings and expanding their pouches. Being perfectly white under the tail, they can be seen at a great distance while in this attitude; I have however never seen a female near a cock, as apparently they live quite separate. During the month of May the cocks entirely disappear from the cultivated lands, leaving the hens behind them; they, I have every reason to believe, go down to the extensive grass marshes which stretch along the banks of the Guadalquivir. The young bustards are hatched in the large corn plains about Seville, and are able to take care of themselves when the corn is cut in July. At the end of that month, when all the corn is cut and no cover remains, the young birds and hens follow the cocks to the *marisma*, as they call these great marshes in Spain.

"The birds are very difficult to shoot, and many a long day I have spent without any success in hunting them about. The only chance is, to hide in a ravine or ditch, and send men who know the country round the birds to try and drive them over you. They sometimes succeed in this, but not very often. The heaviest bird I shot weighed 28 lbs.;

this was before the hens came, which may perhaps account for this bird being two pounds heavier than any I shot afterwards. The largest bird, from tip to tip of wing, measured 7 feet 3 inches; this bird weighed 26 lbs. The 28 lbs. bird measured but 7 feet 1 inch.

"The birds of a year old weigh from 8 to 10 lbs., and are much the best to eat. I did not shoot a hen.

"All the birds I shot had their stomachs perfectly crammed with barley, both stalks and ears, the leaves of a large-leaved green weed, and a kind of black beetle. The pouch is surrounded by a layer of fat fully an inch thick. I may add that the bustards when flushed generally fly two miles or more, sometimes at least a hundred yards high. They never try to run; one that I had winged making the most awkward attempt possible to get away from me, and though a young bird, showing much more disposition to fight than to get away by running. They fly with a regular flap of the wings, and much faster than they appear to go. I cannot imagine greyhounds being able to catch bustards, though there seems to be good authority for believing they did. There were a great many Little Bustards about also, but I never followed them, as I liked the large ones better."

To my friend John Wolley, Jun., a good ornithologist, who had been in Spain and North Africa, I wrote in reference to the Great Bustard, and was immediately favoured with the following answer:—

"My very little acquaintance with North Africa does not extend beyond the neighbourhood of Tangier, and there I did not see the Great Bustard, nor have I received its eggs from that quarter in the several packets which have been forwarded to me; but this proves nothing; it only renders it probable that this bird is not common in the immediate vicinity of that town.

"Of Spain I have almost equally little to say. One day, about the month of September, going up the Guadalquivir in a steam-boat to Seville, I saw several flocks of the Great Bustard at no great distance from the river banks, on the level, and at that time of the year burnt up, plains which extend, almost without trees or enclosure, on each side of the Guadalquivir. These flocks consisted, as I remember, of four or five birds each; and from the deck of the vessel, which was almost on a level with the land, they appeared to be walking in file, some with their heads down, and reminding one of Gilbert White's note, 'Bustards upon the downs look like deer in the distance.' This appearance of walking in a row was probably deceptive. There was nothing in their manner to give the impression that they were timid, or very cautious, but one at least of a party frequently had its head raised as the steamer passed at a few hundred yards' distance, and with the help of my glass I thought this was generally a cock bird. On one occasion, as the boat came suddenly round a corner, several of them rose together from the edge of the water, springing hastily to the height of forty or fifty feet, nearly perpendicularly, partly perhaps to clear the bank, and then turning suddenly and somewhat clumsily, and after a few more not rapid strokes, sailing along with the arched form of wing so general in game birds.

"I have now told you all I know about the Great Bustard in Spain. I wish I had more to say about it. I was told that the Spanish name was *Abutarda*, which is, I should imagine, connected in some way with the specific name '*tarda*,' for the bird can hardly be called 'slow,' but I do not know who gave it its scientific appellation. On the occasion I

have referred to, a Spaniard on board the steamer told me that two or three months earlier in the year was the time for shooting the bird, and that then they were not difficult to approach with the assistance of cattle or carts, if I remember right. This would of course be in the breeding season."

My next communication was received from John Britton, Esq., so favourably known for the great extent of his interesting labours. It is copied from a letter in his possession, with permission to use it, and refers to Salisbury Plain:—

"A man, about 4 o'clock of a fine morning in June 1801, was coming on horseback from Tinhead to Tilshead. While at, or near, an enclosure called Asking's Penning, one mile from the village of Tilshead, he saw over his head, about sixty yards high as near as he could estimate, a large bird, which afterwards proved to be a Bustard. The bird alighted on the ground immediately before the horse, which it indicated a disposition to attack, and in fact very soon began the onset. The man alighted, and getting hold of the bird endeavoured to secure it; and after struggling with it nearly an hour he succeeded, and brought it to Mr. J. Bartley of Tilshead, to whose house he was going. Not knowing the value of such a bird, he offered it to Mr. Bartley as a present; but Mr. Bartley declined to accept it as such, though he much wished to have it, and after repeated solicitations prevailed on the man to receive for it a small sum, with which he was perfectly satisfied. During the first week that Mr. Bartley had this bird in his possession it was not known to eat anything; however, at length it became very tame, and would at last receive its food from its patron's hands, but still continued shy in the presence of strangers. Its principal food was birds, chiefly sparrows, which it swallowed whole in the feathers with a great deal of avidity. The flowers of charlock and the leaves of rape formed also other parts of its food. Mice it would likewise eat, and in short almost any other animal substance. The food on passing into the stomach was observed to go round the back part of the neck.

"Mr. Bartley is of opinion that the idea of the Bustard's drinking is erroneous; in support of which he says, that during the time this Bustard was in his possession, which was from June till the August following, it had not a drop of water given it, after two or three weeks at first. This fact he considers as a proof that the generally received opinion of a Bustard's drinking is untrue.

"This bird was judged to weigh upwards of 20 lbs., and to measure between the extremities of its wings when extended about 5 feet, and its height was about 3½ feet. Its plumage was beautiful; and from its gait, which was extremely majestic, a spectator would be led to infer that it was sensible of its own superiority over others of the feathered tribe.

"In August Mr. Bartley sold this noble bird to Lord Temple for the sum of thirty guineas.

"The Bustard inhabits the extensive downs of Salisbury Plain; but its race is now almost extirpated. It is thought that not more than three or four are now remaining. Some time in the last summer (viz. 1801), while Mr. Bartley had this bird in his possession, a nest, supposed to belong to this bird, or at least to his mate, for Mr. Bartley's bird was judged to be a male, was found in a wheat-field on Market Lavington Down.

It contained two eggs; they sometimes lay three, though very seldom; they are about the size of those of a goose, of a pale olive-brown, with small spots of a darker hue. The nest was made upon the ground, by scratching a hole in the earth, and lined with a little grass. The eggs were rotten, and had probably undergone a period of incubation.

"An instance of a Bustard attacking a human being, or even a brute animal, of any considerable size, was, I believe, never before heard of; and that two instances of this kind should occur so nearly together may be considered very remarkable. About a fortnight subsequent to the taking of this bird, Mr. Grant, a respectable farmer of Tilshead, was returning from Warminster Market, and near Tilshead Lodge, which is something more than half a mile from the village, was attacked in a similar manner, by, as it is thought, the mate of the same bird. Mr. Grant's horse being rather high-mettled, took fright, became unmanageable and ran off, and consequently Mr. Grant was compelled to abandon his design of endeavouring to capture the bird."

From J. H. Gurney, Esq., of Norwich, I received a communication to the following effect:—

"As far as I can learn, the last Bustard killed in Norfolk was a female, which was shot at Lexham near Swaffham, towards the end of the year 1838. The small flock, of which this bird was one, had for some years previously consisted of females only, the eggs of which were frequently picked up, having been dropped about at random in consequence of the absence of male birds, the latter having become extinct at an earlier date.

"Before horse-hoeing was practised, the large wheat-fields of West Norfolk were often left unhoed, and the Bustards were able to nest in them undisturbed; but horse-hoeing rapidly improved the farming and destroyed the nesting of the Bustard."

My worthy friend Frederick J. Nash, Esq., of Bishops-Stortford, has several times told me, that when he was a young man, and then taking the field as a sportsman, he once saw nine flights of Bustards in one day, not far from Thetford in Norfolk. Some of these birds were probably seen more than once, but at that time, about the beginning of the present century, the country between Thetford and Brandon, and from thence southward to Mildenhall, was considered to be the head-quarters of the Great Bustard in the counties of Norfolk and Suffolk.

Gilbert White of Selborne, in his Diary, mentions, under the date of 17th November, 1782, "That being at a lone farmhouse on the downs between Whorwell and Winchester, the carter told him that about twelve years before he had seen a flock of eighteen Bustards at one time on that farm."

Since the publication of the second edition of the 'History of British Birds,' I have only noticed three instances of the occurrence of this species. One, believed by its size to be a female, was seen on Salisbury Plain by Mr. G. R. Waterhouse of the British Museum, in the month of August 1849, when returning to Salisbury with a party of friends from a visit to Stonehenge. Mr. Waterhouse is well known as an excellent naturalist, and the bird was seen several times on the wing by the party during an interval of eight or ten minutes. The subject is recorded in the volume of the 'Zoologist' for 1849, at page 2590.

The second bird, also a female, was shot in January 1850, at Lydd, in Romney Marsh.

This specimen is in the possession of Dr. Plomley, who recorded the circumstance in the 'Zoologist' for the year 1850, at page 2700.

The third was shot on the 31st December, 1851, in Devonshire. This specimen was preserved by Mr. Drax, and is now in the possession of J. G. Newton, Esq., of Millaton Bridestow, as recorded in the 'Naturalist' for 1852, page 33.

I had long wished to have an opportunity of examining the body of a male Bustard to inspect the gular pouch described by Daines Barrington, in his 'Miscellanies,' 1781, and by Edwards in his 'Gleanings in Natural History,' 1811, and from thence copied by Bewick and myself, but it was not till lately that an opportunity offered. About four years ago the Zoological Society obtained by purchase six or seven young Bustards from Germany. One of these birds, a male, died within a year: the body was examined by Mr. Mitchell and myself, but no gular pouch was found. This we then attributed to the youth of the bird. During the past summer of 1852 one of the males of these birds was frequently observed courting a female. His appearance at such a time was singular: the wings are lowered to the ground, and while covering the sides, the most anterior parts of both wings are brought round in front, so that the bird appears to be surrounded by a circle of his largest wing-feathers: the head and neck are passed backward, and so depressed that the occipital portion of the head touches his back, and in this attitude he struts round his favourite. No inflation of the neck was observed. The females are timid and rather shy. Constant exposure to numerous visitors at the Gardens, with the want of sufficient space for seclusion, probably interfered, as no eggs were produced.

In the month of December last this male bustard, believed to be four years old, unfortunately died, and Mr. Mitchell very kindly allowed me to examine this adult bird.

To give an indication of what I expected to find, I may first quote the words in Edwards's 'Gleanings':—

"A remarkable anatomical peculiarity in the male of the Great Bustard, first discovered by Dr. James Douglas of the College of Physicians in London.

"It is a pouch or bag to hold fresh water, which supplies the bird in dry places when distant from waters: the entrance into it is between the under side of the tongue and the lower mandible of the bill. I poured into this bag, before the head was taken off, full seven wine pints, before it ran over. This bag is wanting in the hen."

My examination of the mature male Bustard sent to me from the Zoological Society's Gardens was confined to the neck only. I very carefully divided the skin, in a straight line from the union of the two branches of the lower mandible to the angle of the furcular bone or merrythought. On separating the edge of this skin on each side to the right and left, a thin delicate transparent membrane was seen covering, and firmly attached to, the anterior surface of the trachea or windpipe, which lies close to the inner surface of the common skin. Separating the skin still wider, there was on each side of the trachea an elongated narrow column of membrane investing and attached to the blood-vessels and ordinary glands of the neck, and extended downwards was attached to the lateral branch of the furcula on its own side. The œsophagus inclines to the right side of the neck in its passage downward. There was no opening under the tongue, and I failed in various attempts to distend any part of the membranes below, either by fluid or by air.

I was disappointed, and began to doubt the accuracy of my own investigation, but on turning to the volume containing a translation of the anatomical descriptions of the many animals dissected by the Royal Academy of Sciences at Paris, published here by an order of the Council of the Royal Society of London, 1702, I found that although the dissections of six Great Bustards, *and all of them males*, were therein detailed, beginning at page 197, there was no mention of a gular pouch, and the following extracts are in accordance with the observations on the soft parts already described:—"The rings of the *Aspera arteria* (windpipe) were entire. In some of the subjects there was on each side a caruncle or red gland, immediately fastened to the *Aspera arteria* and to the carotids. In the palate and lower part of the beak there was under the membrane which covers these parts, several glandular bodies which did open into the cavity of the mouth by several very visible tubes."

Cuvier, in his 'Leçons d'Anatomie Comparée,' 1799, dwells at some length on the blood-vessels, glands and cellular tissue of the neck in birds, but he does not refer to any peculiarity in the neck of the Great Bustard.

Unwilling, however, to offer my statement to the notice of the Linnean Society without consulting the best living authority in this country, namely Professor Owen, I mentioned the subject to him, and had the satisfaction to find that Mr. Owen agreed with me entirely—that there is in the Great Bustard neither an orifice under the tongue, nor a gular pouch; and he had the kindness to send me a written note in confirmation. "The following was the result of my dissection of a full-grown Bustard, with the view of obtaining a preparation of the alleged gular pouch for the Physiological Series:—No. 772 Q. The head of a Bustard, *Otis tarda*, with the mouth and fauces exposed, showing the glandular orifices between the rami of the lower jaw, the tongue, glottis, internal nostril and Eustachian orifice. There is no trace of a gular pouch." The preparation has this description in the Museum Gallery Catalogue.

I am therefore disposed to consider that Dr. Douglas was mistaken as to the species of bird examined; and that the summer seasonal enlargement of the glands and cellular structure in the neck of the Great Bustard, accompanied as it is by the assumption of certain elongated feathers called the beard, and a stripe of naked blue skin on each side of the neck, is analogous to the excess of colour observed on the naked parts of the head and neck in our Turkey cock in spring, and to the increase in the size of the glands of the neck seen in the males of Deer during their rutting time.

XVIII. *On the Ocelli in the Genus* Anthophorabia.

By GEORGE NEWPORT, *Esq., F.R.S., F.L.S. &c.*

Read April 19, 1853.

SINCE the publication of my observations on the genus *Anthophorabia*, in the Transactions of the Society*, my attention has again been directed to the peculiarities exhibited by the principal organs of sense, and to the differences which exist in the comparative anatomy of these structures, the eyes, in the two sexes of insects of this genus. I now propose to offer a few remarks on the nature of these differences, in accordance with certain well-established laws in the anatomy and development of animals, and in extension of views which I have already begun to elucidate in the memoirs I have had the pleasure of communicating to this Society on the anatomy and development of *Meloë*.

On a former occasion† I pointed out the curious circumstance that the male individuals of this genus have ocelli at the sides of the head, instead of the large compound eyes which exist in the females, and other Hymenoptera, and that they have also three ocelli on the vertex. The existence of lateral ocelli in *Anthophorabia*, at precisely similar parts of the head as the compound eyes and ocelli in other insects, is incontrovertible, and yet it has been denied. It is equally certain that these structures, as I shall endeavour to show, are true representatives of organs of vision; and that, imperfect as they are, they are good generic distinctions.

The appearance which they exhibit under the microscope is, indeed, such as might readily induce those who are imperfectly acquainted with the laws of structural anatomy to regard them as merely coloured portions of the surface of the head, and not as ocelli, or organs of vision in any stage of development; and such observers might feel themselves supported in this opinion by the circumstance that there are also appearances on the cephalo-thorax of certain species of Arachnida, in the precise situation of ocelli in other species, which, by some, are regarded as mere spots or markings of the tegument, and not as the representatives of eyes.

This opinion would be fully entitled to respect, so long as its authors maintained it as *an opinion*, and made no attempt to enforce it in opposition to *principles* which are susceptible of demonstration, or to support it by supposed analogies.

To judge aright of the nature of the lateral ocelli, in the male *Anthophorabia*, we must not only remember that they correspond precisely, in situation, to the eyes in the female, but must also call to mind what are the essential conditions of a structure which is specially destined for the *appreciation of light*.

Professor Owen has stated‡ that the lowest form of this structure in Fishes is—

* Vol. xxi. pp. 63 & 79.

† *Loc. cit.* p. 64. t. 8. figs. 1 & 4.

‡ Lectures, p. 202, 1846.

"a minute tegumentary follicle coated by dark pigment, which receives the end of a special cerebral nerve," and he exemplifies this by reference to the eye of the Myxine and Lancelet, and also to that of the *Amblyopsis spelæus**, a fish which constantly resides in the dark caverns of Kentucky, and which at first was supposed to be completely eyeless, but which now is shown by Tellkampf † to possess eyes;—the fish, *Amblyopsis*, like the insect, *Anthophorabia*, having been misobserved in this respect, through imperfect investigation. The condition of the eye in these low forms of the organ in Fishes is very similar to that of the simple eyes in their lowest form in Insects. The eye of the insect, as long ago shown in my paper on *Meloë*, read to this Society, is, like all the external organs of its body, a tegumentary structure. It originates in a little cavity, pit, or simple depression, in the substance of the tegumentary portion of the head, which, lined with pigmentary substance, is more or less deep in proportion to the perfection of the organ, and it is covered in on its exterior by a transparent portion of the external layer of tegument, which forms the *cornea*, and affords a free passage to *light*, which is received by the retina, or termination of a cerebral nerve at the base of the organ. This is the principle of construction, and the condition of the ocellus, or simple eye in *Anthophorabia* (Tab. X. fig. 10 *b*, *c*), as in other insects. In the most perfect form of ocellus in Insects, an iris and a lens also are present. The ocelli of the vertex, in *Anthophorabia*, are the most perfect in their structure (*c*). The *cornea* is quite transparent, nearly circular in shape, and well-defined at its margins, as may be seen, with some care of manipulation, with the microscope; but it is much flattened, and forms only a very slight portion of a segment of a sphere. The *choroid* is deeply coloured, being formed of distinct pigmentary granules, which clothe the shallow cup-shaped cavity of the organ. The presence of this pigmentary choroid indicates the *light-receiving* function of the organ, but whether this organ be simply capable of appreciating light, or whether also of distinguishing form, its focal length of vision must necessarily be very short, so that in this respect the facts of structure accord well with the observed and with the presumed habits of the insect.

The ocelli at the sides of the head (*b*) have the same general structure as those on the vertex, but are much more imperfect, in so far as respects the choroid; so that these ocelli may fairly be regarded as *simple appreciators of light*. The form of the cornea in these is an elongated oval, or lozenge-shape.

In all well-ascertained conditions of the simple eye in insects, the organ is found to contain, in addition to the parts mentioned, a concentrating refracting medium, a lens-like body, which is situated immediately behind the cornea, as was shown by Müller in the Arachnida ‡. This lens-like body does, I believe, exist in the female *Anthophorabia*; but whether this structure, on which chiefly distinct vision and the power of the single eye of

* *Loc. cit.*

† M. Th. G. Tellkampf in Müller's Archives for 1844, p. 381. See also fig. 50, p. 176, Owen's Lectures, 1846. Also the remark in Dr. F. H. Troschel's Report on Ichthyology for 1844, that the *Amblyopsis spelæus* "possesses minute eyes covered by the integument" (Ray Society, Reports on Zoology, 1847, p. 563). This is exactly what might be expected, seeing that, in all animals, the *cornea* is, originally, continuous with and forms part of the tegument.

‡ Physiol. des Gesichts-sinnes, p. 315. Annales des Sciences Naturelles, t. xvii. p. 232. Meckel's Archiv, 1829, pp. 38, 208.

distinguishing forms depend, exists in the most perfect of the eyes of the male, those of the vertex, I am not yet entirely satisfied. I have certainly detected appearances, in the nymph or pupa state of the male (fig. 10 *b*), which have led me to think that the *lens* is then present; but I have not satisfied myself of this in the perfect insect, and hence the appearances seen may have been due simply to the vitreous body, as it exists in some of the lower forms of the eye among the Annelida.

Whether, however, the lens does or does not exist, is of little importance with reference to the simple question as to whether these structures in the male *Anthophorabia* are the true homologues of the eyes in the female. That they are so I have not the slightest hesitation, after what I have shown, in affirming. The presence of a *cornea*, which covers a *chamber* lined with *pigment*, is sufficient proof to the physiologist and anatomist of the nature of the function of the structure.

The *form* of the cornea, however, shows that the *field* of vision is very limited. The cornea, as already stated, is but very slightly convex, being almost level with the surface of the head. This fact may have conducted some to the opinion that these are not visual organs. But neither the actual *size* of a simple eye, its *form*, nor the degree of its *convexity*, has any necessary connexion with the simple faculty of perceiving light. The convexity of the cornea has relation only to the *extent of angle*, or *field of sight*. The more convex, and the more elevated the eye is above the surface of the head, the greater proportion of a sphere does it necessarily include; and, as long ago shown by Prof. Müller, the greater the segment of a sphere formed by the eye, the greater is its expanse, or *field* of vision; while, on the contrary, the flatter or more depressed it is the more limited is this field, and the shallower the *chamber* the shorter is its *focal distance*.

The presence of the *lens* in the simple eye is essential to rendering the sight of images, and the appreciation of form, more or less perfect; and it does this in proportion to the more or less correct relation which it bears to other conditions coexistent with it.

With regard to the nerves supplied to these eyes, I may state that although I have not been able to trace those of the vertex so satisfactorily in the male *Anthophorabia* as I could have wished, owing to the numerous muscular fibres which run parallel to them, yet I have succeeded in tracing the optic nerve (*d d*) from the side of the cephalic ganglion, or rudimentary brain (*d*), transversely, in the direction of one of the lateral ocelli (*b*); and I believe, also, that I have distinguished the nerve which goes to the middle eye of the vertex (*c*). The nervous trunk which is given to the middle ocellus in Insects I have already shown, in my paper on *Pteronarcys* *, is formed of two closely approximated nerves, one from each cephalic ganglion, as found by a careful dissection of that insect, and also of several Hymenoptera; and this probably is its condition in all other insects with three ocelli on the upper surface of the head.

I may here also refer to what is stated in my paper on *Meloë*†, that there seems reason to think that in the Arachnida, and probably also in insects, the ocelli originate in the same way as the dermal tubercles, from which they appear to differ chiefly in the mode of development of their nuclei and nucleoli.

* Linn. Trans. vol. xx. p. 440.

† *Ibid.* vol. xx. p. 342.

Further I may mention, with regard to the question concerning the eye-spots in the Arachnida, that I have found by dissection in the *Scorpionidæ*, not only that these are always situated in the exact place of eyes in other species, but also that they always receive a nervous filament from the same optic nerve which supplies the distinctly recognised organs of vision.

These facts, I trust, will be sufficient to show the general correctness of the description which I originally gave of the male *Anthophorabia*, that it is distinguished by the possession of ocelli, both at the sides of the head and on the vertex.

May 9, 1853.—To the foregoing remarks I may add a word on the condition of the eyes in the so-called *blind Crustaceans* from the caves of Kentucky. Distinct eyes exist both in *Triura cavernicola* and in *Astacus pellucidus*, Tellk. In *Triura* the eyes have very short pedicles, and are almost close together. In *Astacus* (fig. 11) they are partially concealed beneath the front of the head (*b*); their pedicles are conical, much shorter than in other species of the genus, and possess but little power of motion. The eye itself (fig. 12 and 13 *b*), although existing as a distinct structure, is destitute of a pigmentary choroid, in which respect it may be compared to the eye of the *Albino*. But the hardened tegument which clothes the entire organ is thinnest and most transparent in that part which forms the cornea (*b*) in other crustaceans; so that, although the eye may be unfitted for distinguishing form, the creature may yet possess the faculty of perceiving the small amount of actinic rays of light which penetrate into its subterranean abode. The cornea also exhibits an appearance of being divided into a few imperfect corneales at the apex of the organ (fig. 14), and the structure behind these into chambers, to which a small but distinct optic nerve is given (fig. 13 *d d*).

Probably other Articulata, which have been supposed to be entirely destitute of eyes, and, consequently, of the power of perceiving light, will be found to have the tegument which covers the place of the supposed lost organ thinner and more permeable to light there than in other parts. It seems fair to infer that this may prove to be the fact in all, from the already acknowledged susceptibility of some of the supposed eyeless insects to the presence of light; and also from the circumstance that in one of the Coleoptera, and in an Orthopterous insect, of the dark caves, *Adelops hirtus* and *Phalangopsis* ——?, the eye, as in others of the tribe, is distinctly indicated, as already shown by Tellkampf and by Thomson*. Hence we may fairly assume that the supposed eyeless Articulata differ from others of their class rather in the *degree*, than in the entire absence, of power of appreciating light.

* Annals and Magazine of Natural History, vol. xiii. p. 112, No. 82. Feb. 1844.

EXPLANATION OF THE FIGURES.

TAB. X.

Fig. 10. Front view of the head of the male *Anthophorabia fasciata*, highly magnified, and seen by transmitted light. A. The antenna, formed of ten joints, 1 to 10. *b.* The lateral, and *c.* the vertical ocelli. *d.* The rudimentary brain. *d d.* The optic nerve. *e.* The labrum. *f.* The mandibles. *g.* The labium. *h.* The maxillary palpi. *i.* The extensor, *k.* the flexor (?), and *l l.* the adductors of the antenna. *m.* The extensor, and *n.* the flexor of the distal joints of the antenna. *o.* The antennal nerve. *p.* The œsophageal ring. *q.* The subœsophageal ganglion, protected by *r.* the basilar apophyses of the head. *s.* The sub-epicranial apophyses, to which are attached, on their inner surface, the extensor of the antenna *i*, and on their external part of *t.* the extensor of the mandible. *u.* The flexor of the mandible. *v.* Extensor of the maxilla.

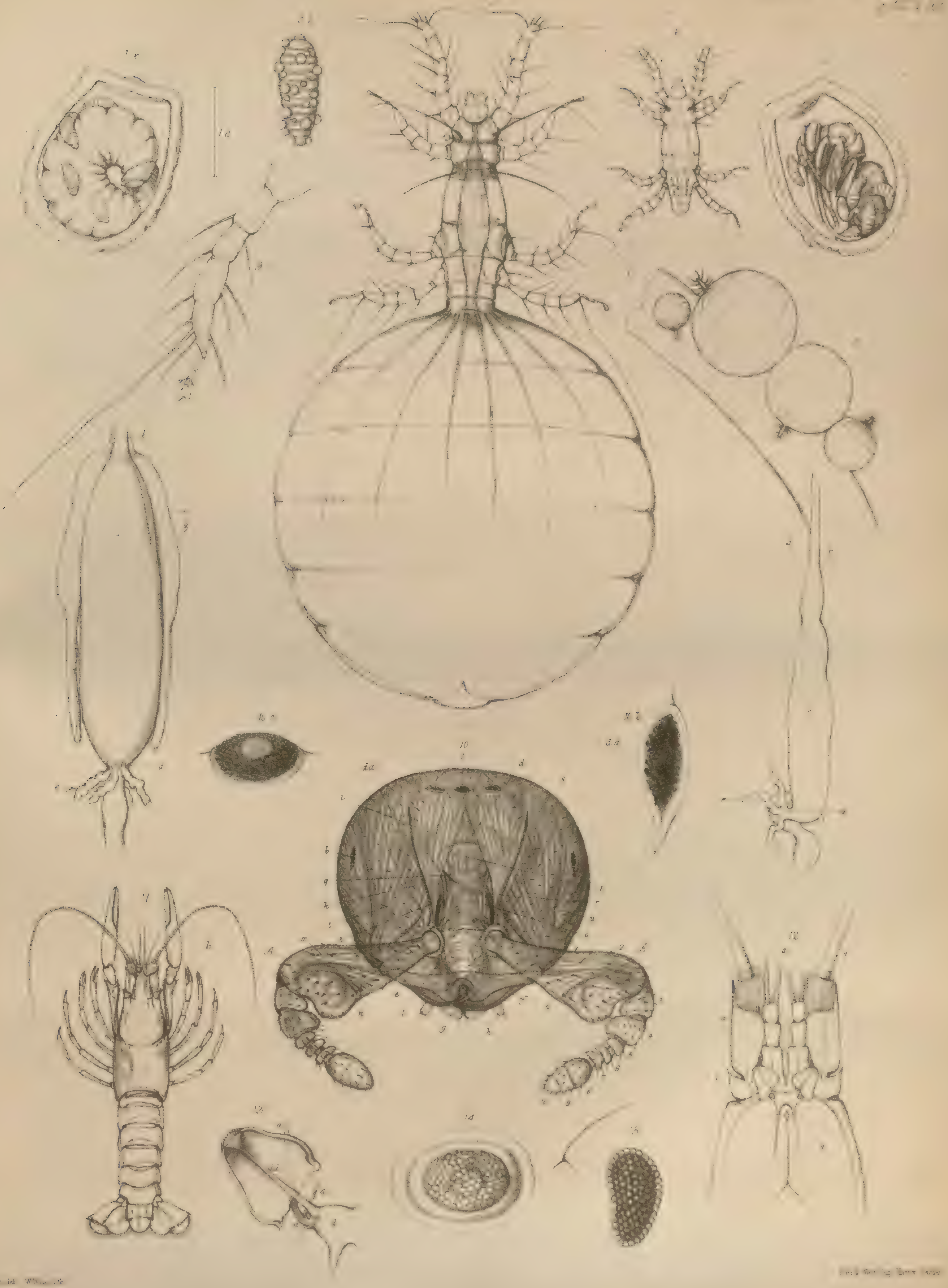
Fig. 11. A young *Astacus pellucidus* from the caves of Kentucky, showing the presence of the eye (*b*).

Fig. 12. Dissection of the cephalic portion of the young *Astacus*, by removal of the upper surface of the head, to show the distribution of optic nerves from the brain (*d*) to the eyes (*b*).

Fig. 13. The eye, &c., highly magnified. *a.* Antennal nerves. *b.* The cornea. *c.* Brain. *d d.* Optic nerve.

Fig. 14. Surface of the apex of the cornea, showing the rudimentary corneales.

Fig. 15. The eye of *Tallitrus locusta*, showing distinct convex corneales; for comparison with *Astacus*.



XIX. *The Natural History, Anatomy, and Development of* Meloë (*continued*).

By George Newport, *Esq., F.R.S., F.L.S. &c. &c.*

Third Memoir.

The External Anatomy of the Larva of Meloë *in its Relation to the Laws of Development.*

Read November 2nd, 1847.

HAVING traced the natural history of *Meloë*, in the preceding Memoirs, I shall now examine its anatomy, with reference to those principles which regulate the formation of animal bodies, and which seem to be the links of connexion which associate peculiarities of instinct with the evolution, and with the functions of special structures,—commencing this with the Anatomy of the tegument.

1. *The Tegument of the young Larva.*

The tegument, the parietal tissue of the body, little important as it may *seem* to be when cursorily examined in the adult *Vertebrata*, is nevertheless, in a physiological point of view, both in the vertebrated and in the invertebrated animal, the primary and essential foundation-structure of the organized being. Like the earlier tissues of plants, it is at first composed entirely of nucleated cells. It is derived immediately from a delicate, transparent layer of semifluid cells which constitute the blastodermic envelope that is formed around one portion of the yelk shortly after the disappearance of the embryo vesicle in the ovum, subsequent to impregnation. This has already been shown in the brief outline of the course of development, and in the delineations which I have given of the ovum of that "atomic" of creation, *Stylops**; and I shall hereafter have to show that the same general laws which govern the development of that atomic existence regulate equally that of *Meloë* and of Man. This blastodermic layer of cells, folded on itself, and partially inclosing the yelk, is the structure from which the whole of the organized parts of the body concerned in the voluntary functions of the animal, are immediately derived; and, as embryologists are aware, it is to the foldings, the intus-susceptions, the extension or the shortening of portions of this structure that the primary form of the animal body is entirely due; whether it be that of the uniform and simply articulated worm, or of the rudimentary embryo of the most perfect of organized beings, Man.

The principles which thus regulate the ultimate form of the embryo that is to be, and the origination of its future limbs, ere it has any definite structural existence, regulate also the whole of its growth and metamorphoses, whether these are gradual, uniform, and uninterruptedly continuous to their end, as in most of the *Vertebrata*, or whether they are marked by more rapid and extensive evolutions at some periods than at others, as in

* Linnean Transactions, vol. xx. p. 337. t. 14. f. 23–32.

many of the *Invertebrata*, and of which the subject of our present inquiry, *Meloë*, is a striking exemplification.

It is in the tegument itself that every change of form in the external parts of the body is commenced; first in slight reduplications of this tissue to form segments; next in the aggregation or partial coalescence of these into particular sets, or regions; and lastly in the hypertrophy or excessive growth of the tegument, at definite points, which produces elevations or protrusions from the uniform surface, and which protrusions constitute the origin of the future appendages. It is by the continuation of these processes of growth in the formation of the animal,—and which processes take place by means of the enlargement and repeated fissiparous division of the nuclei of the cells of which the whole tissue is originally composed, and by the further development of these into cells, as I shall elsewhere show,—that the entire growth of the tegument, from the earliest period of its formation in the ovum to its completion in the adult animal, is effected. Portions of this tissue, consolidated by changes which ensue in the function of the nuclei of some of the layers of cells, constitute the hardened *dermo-skeleton*, which protects and gives support to the internal structures of the insect. The nuclei of these cells, instead of continuing to be multiplied by repeated subdivision into separate organisms, which in their turn are evolved into cells, seem more and more to lose their juvenescence, or reproductive power, in proportion as they are made to approach the exterior of the body by the growth of other layers of cells beneath them. They then gradually become altered in function, and the forces of growth being diminished in a ratio inverse to their maturity, earthy constituents are secreted by them in greater proportion than during their previous existence as reproductive bodies. These earthy constituents assume an inorganic, granular, or semi-crystalline form, and constitute the solid material of the hardened skeleton. This process takes place to a greater or less extent throughout the whole period of development of the insect. It commences in some parts even at an early period of the embryo in the ovum, in the solidification of the hard portions of the mandibles. It is this result of change in the function of the nuclei in their full age, and the partial aggregation of their granular contents, which lead to the deciduation of layers of the tegument in the larva. The cells with accumulated earthy matter in their interior cease to be nourished, perish, and become separated from the layers of juvenescent cells beneath them in the vigour of growth; and are ruptured and thrown off as an entire covering when they retard the further expansion of these and of the whole body. The deciduated cells do not differ, other than in these circumstances, from those which are still in the course of enlargement.

The earthy materials thus deposited in the dermo-skeleton of insects have been found by Odier*, Lassaigne†, Mr. Children‡ and others, to consist chiefly of phosphate of lime, with carbonate of potass, some carbonate of lime, and a little phosphate of iron, with, in some species, silica, magnesia and a trace of manganese. This composition led me, ten years ago§, to describe the dermo-skeleton of insects as "an imperfectly developed condition of

* Mémoires de la Société d'Hist. Nat. de Paris, tom. i.

† In Straus Durckheim's Considérations Générales sur l'Anatomie Comparée des Animaux Articulés, 4to. 1828, p. 33.

‡ Zoological Journal, vol. i. 1824, p. 115.

§ Article "Insecta," Cyclopædia of Anatomy, par. xviii. October 1839, vol. ii. p. 882.

bony matter," and as analogous in development as in function to that of the external skeleton of Chelonian reptiles. This view of its nature has recently been greatly strengthened by the discovery by Platner* of star-shaped corpuscles in the tegument of the Silk-worm, very similar to those which have been described by Purkinje, Miescher, Baly†, and others in true bone.

The consolidation of the exterior tegument in insects by the deposition of earthy materials in its tissue, thus appears to be a vital process precisely homologous with that of the formation of bone in the *Vertebrata*; first by the secretion and deposition of granular, earthy, crystalline matter by the nuclei and nucleoli of cells; and next by the more complete calcification of these cells in layers which form one solid envelope. This process, deposition in layers, is recognized by the best observers, Hunter, Flourens, Goodsir, Sharpey, Tomes and others, as the mode in which the bones of *Vertebrata* are increased in diameter, through the agency of their periosteum, and not by the preparatory process of the formation and absorption of gelatinous cartilage cells, as in their first development in the fœtus. According to the experience of these physiologists, the bones of *Vertebrata* grow by the repeated deposition of layers of bony matter on their external surface, formed by the progressive calcification of layers of cells from the inner surface of the periosteum with which the bone is covered, as the woody fibre of exogenous trees is formed, by their bark. The formation and growth of new bony matter in the skeleton of *Vertebrata*, and the solidification of the tegument and of its internal processes in insects, seem thus to be results which differ in these two divisions of animals only in degree, and in the relative position of the structures in which they occur, and not in their actual nature. In the *Invertebrata*, as in the *Vertebrata*, solidification is effected by deposition in layers. The dermo-skeleton of the *Articulata* is endogenous, whilst true bone is exogenous in its mode of growth. Yet the process in both is as identical in principle as that of the formation of woody fibre in the two divisions of the vegetable kingdom. The solidification of the dermo-skeleton is carried to a greater or less extent in different parts of the body, and at different periods of the life of the insect. In the larva, when the formative energies are the most active, and the whole body is in a state of rapid growth, only the exterior layers of cells become partially calcified, by the deposition of a few earthy granules by the nuclei, exactly as the primary osseous deposits are known to take place in the *Vertebrata*. But when the growth of the body begins to be arrested, preparatory to an extensive change to the form of nymph or chrysalis, a greater number of cells become calcified, and the cast-off portion of the tegument is in consequence of greater thickness. Before the change to the perfect insect takes place, not only do more layers of cells become altered, but fibrous tissue also appears to be developed in the most internal layers, intermingled with the osteogenic; and the two, becoming firmly solidified together, thus form the insect skeleton, derived from, and inseparably connected with its dermal tissues. This perhaps may explain the cause of the inseparableness of the fibrous attachments of some of the muscles to solidified internal processes in the perfect insect, some of which, as we shall find, are formed by actual reduplications of the hardened tegument.

The whole covering of the body in the *Articulata* may thus be regarded as analogous in

* Müller's Archiv, Anat. 1844, p. 38.

† Müller's Physiology, by Baly, edit. 1, vol. i. p. 379. 1837.

its mode of development, and in its function, to true bone; and even as homologous with the external bony skeleton of Chelonian reptiles; the internal portions of which are similar in structure, as in office, to the internal processes of the tegument in the *Articulata*.

But if, for the moment, in deference to the opinions of some physiologists, we were to discard this view of the nature of the tegument, and regard it simply as a dermal covering, we must still look upon it as but one structure, formed of layers of cells in different stages of growth; and not as composed of distinct tissues, epidermis, mucous layer, and corium, the definite limits of which it is perhaps impossible satisfactorily to indicate.

When a very young *Meloë* (Tab. XX. fig. 1) is examined a few days after it has left the egg, its tegument affords a complete demonstration of cellæform structure. The whole tissue, if examined under a high power, is then seen to be composed of a uniform layer of irregularly hexagonal cells (fig. 4), which are almost equally distinct in the covering of the head itself as in that of the thoracic or the abdominal segments. In some parts of the tissue, as in the more transparent ones near the spiracles (fig. 5), each cell is seen to contain a very delicate, granular, irregularly stellate nucleus, which I regard as corresponding to the cells seen by Platner in the tegument of the Silk-worm. Those cells which are on the surface of the body are of a somewhat quadrangular form, and they are arranged in a more linear direction than those which are deeper seated. Their nuclei are distinctly granulous, and occupy a very large proportion of the interior of the cells. This granular condition of the nuclei exists more especially in the cells of the thoracic segments, and closely resembles that in which, according to Mr. Tomes, true osseous matter is deposited in the *Vertebrata*. The largest of these cells measures about one two-thousandth of an inch in diameter. The cells in the tegument of the limbs are less uniform in structure than those of the body. On the femora they are slightly tuberculous, so that the limbs are a little roughened on their surface; while on the tibial and tarsal portions they are more elongated and are less distinct. This also is their condition in the antennæ (fig. 6).

The tegument has its own proper appendages in the form of hairs or imperfect spines (fig. 7). Each of these spines projects from the surface of what, at first sight, appears to be a distinct opening in the external layer, but which is an enlarged and altered cell, the size of which, sometimes, is much greater than that of the other cells, and measures nearly one thousandth of an inch. It is circular, with a convex disc, bounded by a distinct margin, and surrounded by the proper cells of the external surface. In its centre is a slight elevation, from which passes out the minute hair or spine, perfectly smooth on its sides, and gradually diminishing in size from its base to its apex. When closely examined each spine is found to be hollow from one extremity to the other. From its central origination, in a distinct structure homologous with that of the other cells of the tegument, I am induced to regard the spine, as, primarily, an excessive growth of the nucleus of a cell, everted and developed outwards as a single structure instead of being subdivided into nucleoli, or of secreting earthy matter, as in other instances, its cavity being continuous with a passage in the layers of cells beneath.

The mode in which the tegument is developed after the insect has left the egg, is similar, as I have already stated, to that of its origination in the blastoderma. I have distinctly ascertained this fact in the young *Meloë*. It commences in the formation of an

envelope around the nucleus within an adult cell, and this is followed by the fissiparous division of the nucleus itself into two bodies, which, subsequently enlarging, have each their own proper cell-wall formed around them; after which the cell-wall of the parent structure disappears, and leaves the young nuclei free to be developed into separate cells, like that from which they have originated. Thus the end of the development of a formative cell is the fissiparous division of its nucleus. This mode of development of the tegument in the young animal, after it has left the egg, is confirmatory of the theory of Schwann with reference to that of the general tissues; and it also accords with the views of Kölliker respecting the division of the yelk cells in the ovum; and with original observations made by myself, to be elsewhere demonstrated, on the mode of formation of the blastoderma.

If a transparent portion of the surface of one of the thoracic segments of a young *Meloë* which has been for some months in strong spirit, be covered with thin talc, with a little fluid around it, and be then examined by transmitted light with a magnifying power of four hundred and fifty diameters, we can immediately recognize the granular, nucleated external cells of the tegument. If then we approach the lens to the object, so as to be too near to have the external cells in focus of vision, the layer of cells beneath them is brought into view. The cells of this deeper-seated layer are smaller than those of the outer one. If the specimen examined has been several days from the egg, before immersion in spirit, then these cells, instead of having each a single granulated nucleus like those of the outer layer, are found to contain each two nuclei of equal sizes, closely approximated together, but perfectly distinct, and inclosed in one common envelope (fig. 8). In some of the cells the two nuclei are more separated than in others, while in those which have most recently changed they are closely approximated. Occasionally the original nucleus of a cell, not yet divided into two, is observed, in the commencement of its change, with a fissiparous emargination on one surface; but this fact can only be seen when the examination happens to be made on an insect in which the tegument has not far advanced in its changes. The fissiparous division of the nucleus thus appears to be the usual mode of growth of all cellæform tissues.

Although the solidified tegument supplies the place of a true skeleton in the *Articulata*, it is also the agent of other functions; which are of as much importance to the welfare of the animal physiologically, as this is anatomically. It is the medium of the transudation of effete matters from the surface of the body, the retention of which would be detrimental to the entire organism. The cellæform structure of the tegument enables us readily to understand its adaptation to this office. But, besides this, it is subservient to another function, which is equally important with that of transudation,—the aëration or oxygenation of the fluids. This is effected solely by the tegument in the very young embryo in the egg; but as the embryo is advanced to maturity, the function is shared by, and, after birth, is almost entirely performed by respiratory organs, which originate in, and are constantly connected with the tegument as spiracles, or breathing orifices in the sides of the body (fig. 1 *b b*).

These respiratory organs are among the last formed of the essential structures of the embryo. I have not been able to detect the existence of spiracles in *Meloë* until nearly

the very last period of the embryo in the ovum; since it is only in the latter periods of embryonic life, when the last portion of the yelk is inclosed in the thorax of the young insect, and when the blood has begun to be circulated, and requires to be more extensively aërated than it has already been, that organs of respiration are formed.

It is exceedingly difficult to detect the existence of spiracles in the young *Meloë* even at the moment of its leaving the egg, although formed before its escape; but at the end of a few hours, or a day, the spiracles of the trunk become distinct, although those of the abdomen are still exceedingly small. With a magnifying power of three hundred diameters they may then be seen in specimens that have been preserved in spirit. There are then *ten pairs* of spiracles (fig. 1 *b b*), *one pair* (fig. 9) in the meso-thoracic and nine pairs in the abdominal segments. They are placed on the lateral margin of the dorsal portion of the segments on each side. The first two pairs are very much the largest, and are situated, the *first* in the anterior of the mesothorax, and the *second* in the first of the abdominal segments, the fifth segment of the body. The remaining spiracles are each not more than one-third the size of the three anterior ones, and are situated in the abdominal segments, one pair in each, from the sixth to the thirteenth inclusive.

The structure of the spiracle in relation with that of the tegument, at this period, is exceedingly interesting. The two pairs of large spiracles (fig. 9) have a circular opening, with a free, smooth margin, which projects from the surface, and is bounded by the edges of the external layer of dermal cells. The orifice of the smaller abdominal spiracles (fig. 5) is at first simply an irregular oval opening, or space between three dermal cells, bounded also by a slightly projecting margin, and very similar in appearance to the stomata on the surface of the leaves of plants; thus distinctly indicating, in accordance with the views of Schleiden and Schwann, the close analogy which exists in the mode of formation of animal and vegetable tissues. The two pairs of thoracic spiracles seem to be in a more advanced stage of development than the abdominal, but in their internal condition the whole are very similar. The two anterior pairs open each into a hollow, somewhat spherical cavity, or follicle, communicating with a sinus in the granular tissue of the segment. The diameter of the cavity is about three times that of the spiracle. It is narrowed at its bottom, and there are faint indications of its further extension into the body. The follicles with which the spiracles of the abdominal segments communicate, are also much smaller than those of the thorax, and they are less clearly defined. A follicular cavity in the granular tissue of the body thus appears to constitute the *earliest* condition of the respiratory organ in the young *Meloë*, and probably also in other air-breathing *Articulata*; since these cavities in *Meloë* are precisely similar in their general appearance to those described in my former memoir in the very young *Stylops*. They also resemble in some respects the respiratory organs in *Sialis*, which, at the moment of leaving the egg, has its abdominal branchiæ filled with granulous matter, into which delicate undeveloped ramifications of the tracheæ penetrate. In *Meloë*, the parietes of the cavities are lined with an aggregation of minute embryo cells, or nuclei, of rounded shape, and similar dimensions, each one measuring about one five- or six-thousandth of an inch in diameter. Each of these embryo cells has within itself a separate nucleus. The cavity or follicle bounded by them is the commencement of the spiral-fibred trachea, the lining membrane of which, formed of these cells, is

always continuous with the external layer of the tegument, and is thrown off with it at each change. Whether the spiral fibre of the trachea, which is in the course of formation, originates, as believed by Platner, in the nuclei of cells, I am not prepared to affirm; but from the existence of nuclei in those which compose the walls of these cavities, it is probable that such may be the case.

The tegument of the head affords some peculiarities of particular interest. The cells are smaller and more uniform in size and shape than on the body and limbs, and measure each less than one two-thousandth of an inch in diameter. But those which cover the antennæ are much larger, and are as irregular as those on the legs. The eye (fig. 10), which, as formerly shown, is a single structure in this stage of *Meloë*, fitted only for near vision, has its large projecting cornea formed entirely of layers of perfectly transparent dermal cells, which are continuous with those that cover the parietes of the head, but are somewhat smaller, and measure about one three-thousandth of an inch. Those which form the circumference, and general surface of the cornea, are each slightly convex, and are all of the same size, like the corneales in the compound eye of the perfect insect*; while the centre of the cornea, the focus of the line of vision, is occupied by a single cell, much more projecting, and more than twice as large as the others. This condition of the cornea in the young *Meloë*, although perfectly distinct, is very difficult to observe, owing to the circumstance that as yet the cells constitute only portions of one nearly uniform transparent tegument of a single organ, and are not freely isolated, as is the case with the corneales in the imago. It is from this cause that these presumed embryo corneales in the larva can only be detected when the object is placed on its side, and when a high power of the microscope is employed.

This is the condition of the external portions of the tegument. When the young animal has been a few days from the egg, the deeper-seated layers of cells have in part united longitudinally, and constitute a fibro-cellæform structure, which gives attachment internally to the muscles; while the external layers continue to grow and be reproduced as distinct cells. The internal layers thus constitute the true dermo-skeleton. This may assist to explain what I have yet to demonstrate; that the organs of support which exist in the interior of the body in the perfect insect, strong bone-like processes, which give attachment to muscles, and which in some parts support and protect the nervous centres like the vertebræ in Chelonian reptiles, are solidified portions of the common tegument extended inwards, and consolidated during the metamorphoses of the insect.

Each segment of the dermo-skeleton in the imago, as shown by the late Professor Audouin†, is made up of distinct pieces, the separate development of which is but slightly indicated in the very young larva. Some of them, however, are marked in the head and thoracic segments. In the head a triangular suture is extended forwards in the middle line of the dorsal surface, between the eyes, and, diverging on either side to the antennæ, marks its line of union in the ovum. The *prothorax*, *meso-thorax*, and *metathorax*, are also marked by a median dorsal sulcus, indicating the original individuality of the two sides in the embryo, and their junction after the last parts of the yelk have been received

* See Remarks on the Origin of the Ocelli, Linn. Trans. vol. xx. p. 342.

† Annales des Sciences Naturelles (prem. série), tom. i. 1824.

into the prothorax. The dorsal region of the body in the young *Meloë*, as in the very young larvæ of most of the *Articulata*, is not so far advanced in its development as the sternal and ventral, at the period when the insect leaves the ovum; owing to its being the last portion that is formed. Consequently we find the insertions of the legs in the young, at a relatively greater distance from the median line of the sternal surface than in the imago. The legs are as it were appendages of the sides of the body; while the respiratory orifices, which properly belong to the membrane that connects the dorsal with the ventral surface in the perfect insect, actually exist in the young *Meloë* at the sides of the dorsal region. But in proportion as the growth of the body is advanced the relative dimensions and position of these parts are changed. The growth of the sternal surface, after the insect has left the ovum, does not proceed so rapidly, and is not carried to so great an extent as that of the dorsal; the result of which is that the coxæ of the legs become relatively more and more nearly approximated to the median line, and are transferred to the under surface of the body in the perfect insect. The spiracles also, from a like cause, are changed in their form and position, and are gradually removed from the dorsal to the lateral surface by the more rapid growth and extension of the former. The dorsal region itself is widened, is rendered more convex, and ultimately becomes the most voluminous portion of the whole body. These facts of development are common to all insects, and are well-indicated in the structure of the adult larva of *Meloë*, in which the entire form of the insect is completely altered by this difference in the relative development of its parts.

Read April 18th, 1848.

2. *Tegument of the Full-grown or Pseudo-larva.*

Every natural change in the animal body, whether of structure, of function, or of instinct, takes place by regular and inevitable gradations, all of which seem to depend on immutable laws of organization. No strongly-marked transition from one condition to another, whether in character, in form, or in degree, ever occurs by sudden or violent alterations, without deranging the body, the organ, the function, or the instinct that is subject to such change, and inducing its permanent impairment, or premature annihilation.

Newton, the pride of physical science, was as fully impressed with these truths, with regard to the animal body, as with their correlatives which regulate the universe itself, when—pondering on the laws which he was then proving govern light and space—he wrote the following words:—"Idemque dici possit de uniformitate illâ, quæ est in corporibus animalium*." These views with regard to the uniformity of structure and development in organized beings,—originally glanced at by Malpighi in his anatomy of the Silkworm in 1669†, and dwelt on to some extent by our own almost forgotten countryman Dr. Willis, in 1682‡,—have since been amply demonstrated by the illustrious Geoffroy Saint Hilaire§ and his numerous followers; and it is now my humble endeavour still further to

* Optics. Edit. S. Clarke, p. 346. 4to. 1706.

† Dissertatio epistolica de Bombyce; Societati Regiæ Londini dicata. 4to. Londini, 1669.

‡ Opera Omnia. 4to. 1682.

§ Philosophie Anatomique des Monstruosités Humaines. 8vo. 1822. Also, Cours de l'Histoire Naturelle des Mammifères. 8vo. 1829.

exemplify them, together with the views of Schwann on the formation of tissues, in the Anatomy of *Meloë*, and to apply the principles on which they are based to the *functions* also of animated existence, in illustration of their dependence on special structure.

It is the great principle of gradational development which operates so markedly in the organization and habits of many of the *Articulata*, and which causes them, as we have already seen in *Stylops* and *Meloë*, to differ so greatly in every respect in their young and in their adult states. In each of these, the general conformation of body, and of each particular organ, seems to have reference to some speciality of structure or of habit; but,—owing to our imperfect knowledge,—as who will presume to say, in denial of this view, that he is cognizant of *all* the facts in the natural history of even one species of animal?—the object or applicability of every variation of structure is not always readily traceable in its *details* of colour, of armature, of size, or even in the minutiæ of form, although invariably evident in general design. We have seen this in the structure of the mandible, in the condition of the eye, in the size and power of the limbs, in the peculiarities of their tarsi (fig. 12), in the acuteness of the physical senses, and in the vivacity of the movements of the young *Meloë* in its incipient parasitism; and also like, but less needed, and consequently less marked conditions in *Stylops*. In both we have seen that gradational changes begin to be effected in the organization of the animal immediately the physical conditions in which it is placed are altered; and that these changes commence in its tegument. The *Stylops* larva, covered with its armature of spines, penetrates insidiously into the body of the Bee, and, engorged with nutritious and stimulating juices, increases rapidly in bulk, casts its embryo covering, and from an active becomes an almost quiescent being. Its elongated limbs are atrophied and reduced to mere tubercles. The spines that arm the margins of its segments,—doubtless, designed by creative Omnipotence to aid it in forcing its way into the body of the bee-larva,—as the spines on the pupa-case of the *Cossus* assist that insect in its transit to the outlet of its burrow in the trunk of the Willow, and enable it to force its way through its strong silken cocoon, preparatory to its liberation as a Moth,—then become utterly useless to the young *Stylops*, are entirely thrown off at its change of tegument. In like manner, *Meloë*, most active immediately after it has left the egg, and when designed to attach itself to the irritable Bee for conveyance to its nest, gradually becomes, after it is located and nourished there, the heavy apodal pseudo-larva. The structure of its tegument then undergoes considerable change. The forces of growth in this tissue, centred in the nuclei of its cells, and the repeated division and development of these into constituent producing portions of the whole, seem gradually to become less and less energetic at each change of tegument, the intervals of which are progressively extended. When reproduction in these constituents is long retarded, throughout the whole or chief portion of them, their arrest seems to limit the entire bulk and form of the being in that stage of its exis ence, and new series of changes are induced. But when growth proceeds less rapidly in some of them than in others, the form of the entire body, or of some particular region of it, is changed. The tegument of the pseudo-larva, and that which the adult larva throws off on assuming this condition, afford ample demonstration of this view. The body of the larva, altered from that of the slender, agile little being, with elongated limbs, and long caudal styles, as when it left the egg, to the heavy, fat, convex grub (fig. 13), has been changed in

its form by almost imperceptible individual differences in the development of the nuclei of the multitudes of cells of which its tegument is originally composed. The greater rapidity of growth in those of the dorsal region has occasioned the enlargement of that portion of the body to an extent far beyond that of the region which is first formed in the production of the embryo in the egg—the ventral surface—and the entire body, as a consequence, has gradually assumed a totally different outline. This primary change in one region leads to secondary changes in another, more especially in its appendages. We have an instance of this in the gradual reduction of the legs to tubercles, their enlargement, even during the feeding state of the larva, not having kept pace with that of the dorsal region; whilst at the period of change to the pseudo-larva (fig. 13), the rapid growth of this region of the body not only most powerfully arrests their further development for a time, but actually conduces to a state of atrophy, as shown in their diminished size, and in the complete deciduation of their terminal armature, the trifid prehensile claws, which we know are so important to the larva in its earliest condition. This effect of rapid growth in the dorsal region is evident not only in *Meloë* but in all larvæ that undergo similar metamorphoses, *Curculio, Anthophora, Ophion*, and other genera. It is not the result of exhaustion of the forces of growth in the undeveloped parts, but only of their retardation, the consequence of excessive development in others. In these views I refer only to the primary and essential means of development in the tissues themselves, and not to those secondary ones, which are presently to be examined, and by which the body of the insect is made to assume the imago form.

The principle which operates in the deciduation of the claws, operates equally with reference to the caudal styles (fig. 1 *d*), which have the same mode of origin as the permanent appendages of the segments, the limbs, of which they are the true homologues. The dermal appendages, spines, hairs, and scales, are similar in their *mode* of origin to the appendages of segments, but are not homologous with them. The latter always originate by an extension outwards of an entire portion of the tegument of a segment; while hairs, spines, and scales originate in the nuclei of the cells of separate layers of tegument. I have detected this origin of hairs in the embryo before it leaves the ovum. Hairs and scales are developed from the more superficial layers of cells, while spines may extend from the more deeply seated. Essentially their origin is the same. In like manner, when either cease to be nourished, their function in the economy is at an end, they become atrophied, and are thrown off with the cast portion of tegument. This is the case alike with the caudal styles and lateral hairs of *Meloë*, with the styles and marginal spines in *Stylops*, and with the enlarged branched spines on the larvæ of many *Lepidoptera*, changes which are the result of other more important ones in the organization of the animal. Function thus is the result of special structure. During the persistence of these organs they are nourished as fully as other structures, and it is only when this nourishment is diminished or withheld that they become atrophied. In many instances, as in the caudal styles of *Meloë* and *Stylops*, and the spines in *Lepidoptera*, the parts involve a large portion of the tegument, and communicate by their tubular interior with the deeper seated layers, and even with the cavity of the body, as in *Lepidoptera* and *Crustacea*. In these cases, the spine, originating apparently in a single cell in the embryo, gradually involves other cells both around and below it in its growth, until from a single part it has become

a multiple of parts, which are thrown off and reproduced like the cast tegument itself, until causes are induced which occasion its atrophy and decay. These causes rarely occur in the *Crustacea*, which do not materially change their form after the earlier periods of life. Hence the tegumentary appendages are usually retained in this Class as permanent structures: but when secondary causes of development and change of form are in operation, as in the metamorphoses of insects, then these appendages also, like the simpler dermal hairs, are deciduated. The communication of the spines, in the *Crustacea*, by their tubular cavity, with the interior surface of the tegument, as shown by a recent French observer, M. Lavalle*, proves that the spine may be an eversion and extension outwards of the whole tissue; but it does not prove, as M. Lavalle seems to think, that this is its original condition, but only that it may become this in the course of its growth as a spine. That this is the correct explanation, and that hairs, and also scales, originate primarily in the nuclei of single layers of tegument, seems proved by the fact that the skin of the full-grown larva of *Meloë* is covered in every part with extremely minute spiniform hairs, which are scarcely as much as one-thousandth of an inch in length (fig. 14). These hairs proceed each from the centre of the cells which form the layer of tegument cast by the insect on assuming the pseudo-larva state. These minute hairs are hollow at their base, like the larger ones, and are simple eversions of the nuclei of the cells of that layer of tegument; and this also is the anatomical condition of scales. That this is the fact is proved by the circumstance that not the slightest trace of these microscopic nucleus-born hairs remains in the tegument of the pseudo-larva of *Meloë*. Still further proof is derived from the facts connected with the atrophy of the spines at the last change of tegument of the larvæ of *Lepidoptera*. In these larvæ the spines, which previously communicate in their interior with the deep-seated layers of tegument, have their nourishment cut off, and their function in the economy destroyed, by the growth and enlargement of cells in their interior, extended at their base from the deeper-seated layers of tegument; so that, on the change of the larva to a chrysalis, small tubercles only remain on the tegument in places previously occupied by elongated and powerful spines.

It is in this way that not only hairs and spines, but also the armature of the distal extremities of the limbs, the claws, are thrown off, and the limbs themselves become atrophied, by deciduation of their external covering, from without inwards, as well as by actual retardation of growth: both of these results are induced to a greater or less extent in proportion as other parts or regions are enlarged.

These are some of the primary laws of the organization and growth of structure, the formation of which, thus commenced, is further advanced by secondary ones; and development is hastened or retarded by the operation of physical conditions,—light, heat, food, and all material influences.

To pass now from the *primary* stages of growth and change to the *secondary*, by which further development is effected, we must first examine the structure of the layer of tegument which the full-grown larva throws off on assuming that state in which alone I have hitherto found this insect—the *pseudo-larva*. This cast portion always partially envelopes

* Annales des Sciences Naturelles, 3me Série, 1847.

the inferior and posterior parts of the body of the pseudo-larva, thrust backwards in a packet, as it is slipped off at the period of change. In the absence of discovery of the larva itself, before it is full grown, this cast skin enables us to indicate its general form and economy, at that period of its existence, as surely as the fossil bone enables the comparative anatomist of the *Vertebrata* to indicate those of the habitant of a former world. The skin of the larva is fissured at the period of change along the median line of the prothoracic segment, and is extended forwards to the head and backwards to the meso- and meta-thoracic segments, exactly as in other insects. By carefully removing this skin from the pseudo-larva, and relaxing it in water for some hours, and then inflating it gently with a blowpipe, the general form of the larva is made apparent. It is a fat, yellow-coloured, elongated grub, with six short legs, formed of short coxal, femoral and tibial joints, covered with delicate scattered hairs, and with tarsi, each of which is a single joint, armed with a single short strong horny claw. The tarsal spines which exist in the very young *Meloë* on each side of this claw,—and which are of so much importance to the insect at that period of its existence in enabling it to cling firmly to its victim, and, relatively with other parts, are so large and conspicuous, that Léon Dufour derived from them the character of his genus *Triungulinus*,—have entirely disappeared at previous changes of the tegument. In like manner also the caudal styles have been removed, being reduced to mere pointed tubercles, as in the larva of *Cryptophagus**, preparatory to their complete obliteration in the pseudo-larva. The body is arched, slightly convex, and formed of fourteen segments, with a few scattered elongated hairs, as in the very young state; and also, as I have already mentioned, is covered on every part with multitudes of microscopic ones, scarcely one-thousandth of an inch in length, each proceeding directly from the centre of nearly every cell in this cast envelope. The segments of the body are nearly all of the same dimensions, and thus give to the larva a more uniform and less articulated appearance than that which it presents in its earliest state, when the segments of the thorax greatly preponderate.

The external organs of respiration have undergone but little change, either in form or in situation; excepting only that the second pair of spiracles are now of the same size as those of other segments. The small size of the whole, relatively to that of the body, seems to indicate a minimum degree of activity in the function of respiration, and consequently a sluggish mode of life, similar to that of the Bee-larva, in the abode of which the *Meloë* is a parasite. The spiracles at this period are not larger than those of the Bee-larva, excepting the anterior pair. The whole are nearly circular in form, and their entrance is protected by a raised horny margin. Internally they are lined by a membrane made up of extremely minute but distinct cells, which form a layer that is continuous with the mucous lining of the trachea. This lining is removed in connexion with the cast skin from the whole of the ramifications of tracheæ connected with each spiracle; and its delicate, hair-like, tubular, uniform divisions, which pass off from the main stems at acute angles, further prove that the capacity of the tracheæ, and consequently their function as respiratory organs, is insignificant and restricted.

This cast envelope of the full-grown larva shows that, up to this time, the head has

* Linn. Trans. vol. xx. p. 352. tab. 14. fig. 34.

undergone but little alteration in form from that of the very young, like which it is marked with a longitudinal and a triangular sulcus. The eye, which in the embryo larva is a single organ, is now a compound one, formed of three facets on each side of the head. In this multiplication of parts it resembles the eye in the lower *Myriapoda*, the *Julidæ*, in which the eye, commencing as a single structure, becomes at its first change a triple one*, preparatory to future subdivision to form the compound eye of the imago. Up to this period the antenna has undergone less change than any other structure of the head, thus proving that, whatever is its function, it is exercised in precisely the same manner in the adult as in the very young larva. But it is in the parts of the mouth that the greatest changes of form have occurred; changes which lead us to infer a change in its economy. The *mandible* of the adult larva, as I have formerly stated, is a short strong corneous organ, totally different from that of the embryo larva. It is in this that the mode of development by anchylosis, or complete union of originally separate parts, in the formation of one structure or body, is most distinctly shown. The mandible in the original formation of the embryo in the egg is the true and legitimate appendage of, at least, one of the basilar segments of which the entire head is composed, and which segment is identical in its mode of origin with the other segments of the body. This fact I had the honour of announcing in the 'Transactions' of this Society, as discovered in the embryo of *Geophilus*†; and although it has been somewhat questioned by Prof. Erichson‡, I have since been enabled to verify it repeatedly, not only in the *Myriapoda*, but also in the embryos of true insects—for example, in *Forficula*. To trace the formation of the mandible, therefore, we must regard it as the articulated appendage of a single segment,—in fact, a true limb in its origin and structure, but which, gradually altered in its condition and form, becomes adapted to a particular function, and to variations in the mode of its employment in that function. The changes in this structure usually take place in animals at so early a period, often, as in the whole of the *Vertebrata*, even during the earliest stages of the embryo, that we are unable to follow them, and satisfy ourselves of the fact of their occurrence. But this is not the case in the lower forms of *Articulata*, the *Myriapoda*, nor even in *Meloë* and many other hexapods. In the embryo of the vermiform *Myriapoda*, as in *Geophilus*, every segment of the body is furnished with a pair of appendages, and this also is the case with each of the segments of the head. These appendages originate at the sides of each segment as minute tubercles, one pair to each. Those which belong to the head appear first, but are followed in quick succession by those of the anterior segments of the body, and sooner in proportion to their proximity to the head. No difference is at first recognizable in any of them, either in form or size; but after a period more or less brief, according to the type and species of animal, the mandible becomes enlarged and changed in its appearance. In the *Chilopodous Myriapoda* it retains the articulated pediform structure throughout the entire life of the animal, and is employed as an organ of prehension rather than of manducation. This is precisely what we have already seen in the very young *Meloë*, which has a mandible jointed and pediform in structure, and penetrant and prehensile in function. The structure of an organ thus indi-

* Phil. Trans. 1841, p. 127.

† Linn. Trans. vol. xix. p. 289.

‡ Reports on Zoology for 1843–44 (printed by the Ray Society); Entomology, by Dr. W. F. Erichson, p. 409.

cates the purpose for which it is employed; and the habits of the *Meloë* larva, and its mode of seizing and attempting to pierce the skin of the bee that conveys it to its nest, confirm the conclusion deduced from the structure of its mandible.

The gradual change of form which the mandible undergoes in the larva state, indicates some modification of function even during the larva period. I have already shown that the mandible in the adult larva is a short thickened corneous organ, more nearly resembling that of the perfect insect: not as in that fitted for cutting and comminuting vegetable tissue, nor, as in the very young, for piercing soft textures, but rather adapted for crushing and bruising. The mode in which this organ is changed in its condition is, first, by deciduation, at the change of tegument, of its terminal claw-like apex, exactly as the corresponding part of a true limb is thrown off at the change on the reduction of the legs to mere tubercles, preparatory to their future re-development in the nymph or pupa in a new form; next, by the growth and enlargement of every part of the structure in a *lateral*, and its retardation in an *axial* direction. The result of this change is a complete obliteration and anchylosis, or permanent union of the whole in one powerful angulated structure, which retains an articulation only with its parent segment. This is the mandible of the adult larva.

Changes, similar in principle and mode of operation, but carried to a far less extent, take place in the other appendages of the cephalic segments of *Meloë*, the maxillæ and palpi, the function of which, like the structure, undergoes but little modification.

The whole of the feeding-period of the larva state, in so far as refers to change in the segments of the body, is scarcely other than one of simple growth and enlargement. Change of form by aggregative development, as we have seen, commences in the appendages and parts of the head; but the tegument of the segments in the larva still retains its original flexible uniform condition, and is scarcely thrown into folds, even at the junction of separate segments. The nuclei of its component cells continue to reproduce, and when the external layer becomes aged and resistant, obstructing the function of the internal, it ceases to be nourished and is removed. But as the entire body advances to its maximum of size, certain forces become active in its internal structures, which lead to those rapid and important changes of form in the whole which we recognise as the *Metamorphoses of the Insect.*

Those structures which are the immediate agents of all voluntary and instinctive movements, *the muscles*, are also those of the Metamorphoses. Nourished to the utmost while the larva is feeding, they keep pace with the tegument in growth. They are connected with the internal surface of the tegument in every part of the body, deriving their origins from it, and having their attachments in it; so that any alteration in them affects the form of the portion they are connected with, and of the whole body, to a greater or less extent in proportion to the degree of their contractility, and to the number and direction of the muscles engaged.

We are entirely ignorant of the secret cause which first excites these structures into action in effecting the metamorphoses, at definite periods of the insect's existence, if it be not, as there seems reason to suspect it is, allied to an accumulation, and subsequent discharge, of force evolved during growth in the structures themselves, a vital endowment of

organized matter: we only know, of a certainty, that it is by the agency of the contractile muscles that the form of the body is rapidly altered at the period of metamorphosis, and that whatever is the origin or the nature of the contractile power, its evolution is accelerated or retarded by physical influences. Alternations of heat and cold, drought and moisture, are favourable to the changes which this power effects, and promote their occurrence, as an unaltered continuance of either of the conditions mentioned retards them. Reaumur found that by keeping chrysalids of the common white butterfly in an ice-house, the changes to the perfect insect were prevented for two years; whilst by removing others in the depth of winter to a hot-house, he induced the appearance of the perfect insects in a few days. I have myself noticed similar facts in the *Hymenoptera*. Some larvæ of *Anthophora*, which I collected in the month of October, and preserved in a warm room through the winter, instead of undergoing transformation, as in their natural haunts, on the accession of warmth, in February and March, did not change into nymphs until some hot days in August, when the temperature of the apartment was greatly increased; and having entered the imago state in a few days afterwards, then lapsed into perfect quiescence, or sleep, as in their natural state of hybernation, and did not become active until the following spring *. Thus alternations of condition are essential to the changes in growth and development, as to the health of the body, and to the evolution of all vital power. This is equally true with reference to the highest, as to the lowest of created beings; to the most perfect, as to the least organized; to ourselves, as to the insect we are examining.

Influenced by alternations of condition in the functions of respiration and nutrition, the muscles of the insect acquire an accumulation of contractile power before the change; and when the larva has attained its full size, and its further growth is arrested, the moment of transformation has arrived, and this power in the muscles constitutes the *secondary* and most evident means of development. Certain muscles in the insect are ranged in the axis of its body, in a longitudinal direction, attached to the internal surface of the tegument in parallel series at the anterior margin of one segment, and extended to the posterior of another; and others are ranged in diagonal, or in transverse series. By the action of the longitudinal ones, aided by the diagonal, and operating on the whole structure, the main portion of the tegument is gradually separated from the worn-out external layer that is to be removed; and by a concentration as it were of the muscular forces in the segments immediately behind the head, this layer is ruptured along the dorsal surface; and, gradually detached from the new covering beneath it, it is slipped off backwards by successive contractions and elongations of the segments.

When this change takes place after the insect has acquired its full growth as a larva,

* Since this paper was read I have repeated this observation. Some specimens of *Anthophora* obtained in the larva state on the 12th of September 1847, were preserved in a room of moderate temperature during the winter; but they did not change to nymphs until from the 7th to the 14th of July 1848, and then only assumed the perfect state in September of the same year; after which they did not throw off the last tegument until January 1849, and became active imagos in February. I pointed out this fact of arrested development, at a uniform high temperature, at a Meeting of the Entomological Society in April 1847. (See Trans. Ent. Soc. vol. v. pt. 2, 1847, p. xi.) I may mention also that five of the larvæ which were the subjects of this experiment, were of a deep *yellow* instead of a *white* colour, and that two of them produced male, and three female imagos, so that difference of colour has no reference to the sex of the individuals.

and has ceased to feed, as at the period at which I have found the full-grown *Meloë*, the muscles effect a complete alteration in the segments both relatively and individually. The abdominal segments, which are the largest while the larva is feeding, are quickly reduced in size when fresh nourishment has ceased to be supplied; while those of the thorax are enlarged, and duplicatures of tegument are formed between each by the shortening of the longitudinal and diagonal muscles.

In the pseudo-larva of *Meloë* (fig. 13) these changes have only commenced; but when the insect passes to the nymph or pupa state (fig. 15), the alteration is carried to a very great extent. The longitudinal muscles of the abdominal segments occasion, by their powerful contraction, broad reduplications of the tegument, the posterior margin of one segment is made to cover the anterior of the one next behind it, and the whole are much shortened. The force of development in this region is from behind forwards, the effect of which is to occasion a rapid enlargement of the head and of the thoracic segments, and the coalescence of some of the latter by aggregation and anchylosis. This is carried to the greatest extent in the segments of the middle of the body, which form the union of the thorax and abdomen in the imago. In some insects the fifth segment of the larva is reduced to its minimum, and disappears as a sectional portion of the animal, its rudiments only being left. In the nymph or pupa of *Meloë* the metathoracic or fourth segment is the shortest, the fifth being further shortened at the next change.

The immediate result of the altered proportions of the abdominal segments, and their removal forwards by the action of the muscles on the tegument, is a re-induction of the forces of growth in the appendages of the thoracic and cephalic segments, and a consequent enlargement of the segments themselves, more especially those of the head. This region in *Meloë* is enormously enlarged, as compared with the head of the larva. But this does not result, as M. Ratzeburg seems to think, from certain observations he has made on *Hymenoptera*, from a coalescence of the head of the larva with the segment next behind it, but it is entirely due to the rapid growth and expansion of all parts of the head at the period of transformation.

The change effected while the larva is passing to the pseudo-larva state, is a commencement of a re-induction of the growth of the appendages of the head and thorax. The legs, then reduced to tubercles, are soon redeveloped beneath the tegument of the pseudo-larva in an entirely new form, with jointed tarsi, ready to be elongated at the instant of change to the nymph.

In addition to the redevelopment of these parts, the rudiments of new organs are produced. The internal respiratory structures are extensively affected by the changes, as is the case in all insects on becoming pupæ, and the result is to occasion the expansion of a fold of the tegument, at the sides of the metathorax (fig. 16 *a*), in which some ramifications of tracheæ are included. The growth of this fold in *Meloë* is soon arrested, and it becomes the future rudimentary elytron of the imago, as in other insects it is the anterior wing.

Minor causes, which it is unnecessary to mention here, not only occasion these parts to be developed to a greater extent in some species than in others, but also effect the production of a second fold from the metathorax, the posterior wing.

Besides these there are other important changes in the tegument in these transforma-

tions, changes which constitute it the true skeleton of the insect. The alterations which the body undergoes in form are not accidental results of the actions of the muscles, *but depend in each species on definite unvarying geometrical principles of force and relation.* Portions of the tegument which give attachment to muscles are folded inwards in the head and thorax, and becoming solidified constitute a rudimentary internal skeleton, some parts of which merely give attachment to muscles, whilst others, as in the *Vertebrata,* inclose and protect the nervous system. These I shall hereafter examine with the *dermo-skeleton* of the imago.

EXPLANATION OF THE PLATE.

Tab. XX.

Fig. 1. The young *Meloë* a few days after it has left the egg, highly magnified to show the structure of the organs of vision, *a*; situation of the spiracles, *b*, *b*; form of the tarsi, *c*, *c*, and caudal styles, *d*; and internal muscular structure as seen by transmitted light.

Fig. 2. Inferior surface of the *Meloë* larva, showing the structure of the pectoral and abdominal portion of the tegument.

Fig. 3. *Meloë* larva seen from above by transmitted light, and showing its brain and alimentary canal.

Fig. 4. A portion of the tegument highly magnified, showing its hexagonal cellæform structure.

Fig. 5. One of the abdominal spiracles magnified, showing the tegumentary cells with irregular granular nuclei.

Fig. 6. One of the antennæ, highly magnified.

Fig. 7. A dermal spine or hair, originating from the nucleus of a single cell, highly magnified.

Fig. 8. Portion of tegument showing two layers of cells, the deeper-seated with their nuclei divided and in the course of reproduction.

Fig. 9. The large or thoracic spiracles.

Fig. 10. The eye of the larva, magnified, showing the cornea formed of tegumentary cells, with the single central ocellus.

Fig. 11. View of the side of the head of the larva.

Fig. 12. One of the tarsi, showing the articulated spines at the sides of the true claw.

Fig. 13. The full-grown or pseudo-larva, with its limbs reduced to tubercles preparatory to change to a nymph.

Fig. 14. Skin of the full-grown larva, showing the microscopic hairs developed from the nuclei of cells.

Fig. 15. The nymph at the period of throwing off the pseudo-larva covering, with its limbs becoming rapidly enlarged.

Fig. 16. The fully-formed nymph.

G Newport, del. W Wing, lith.

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XX. *Notes on the Vegetation of Buenos Ayres and the neighbouring districts.*

By CHARLES JAMES FOX BUNBURY, *Esq., F.R.S., F.L.S. &c.*

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THE principal materials of the following notes are derived from the very extensive botanical collections of the late Mr. Fox, formerly British Minister at Buenos Ayres, and afterwards at Rio de Janeiro. The herbarium formed by Mr. Fox in the neighbourhood of the former city, as well as at Monte Video, Maldonado, and other localities on the northern shore of the Rio de la Plata, and along the lower part of the river Uruguay, during the years 1831, 1832 and 1833, is so considerable, that I am inclined to think it may be viewed as representing a great part of the vegetation of those countries, and may afford sufficient ground for the remarks which I propose to make on its leading characteristics. In a residence of about a month at Buenos Ayres, in the beginning of 1834, I had myself the opportunity of becoming acquainted with the most prominent features and general aspect of the vegetation. The principal published works from which I have derived assistance, are M. Auguste de Saint Hilaire's Report of his Travels in Southern Brazil (published in the Mémoires du Muséum, vol. ix.), and the papers by Sir William Hooker and Dr. Walker-Arnott on the plants of Extra-tropical South America, in the 'Botanical Miscellany' and 'Journal of Botany.' I am indebted to Sir W. Hooker also for very important assistance in naming the species contained in Mr. Fox's collection.

The region of which I propose chiefly to treat, is that lying on both banks of the Rio de la Plata, and on the lower part of the courses of the two great rivers by whose junction it is formed; comprising consequently those parts of the republics of Buenos Ayres and Banda Oriental which lie nearest to the Plata, between the parallels of 33° and 35° S. lat. The collections before me were formed in the neighbourhood of the coast and of the rivers, so that I am obliged to rely upon other authorities for the botanical characteristics of the interior of those countries, in which, indeed, according to such information as I can procure, a considerable degree of uniformity seems to prevail. I shall introduce also some remarks on the vegetation of the southernmost part of Brazil, a district in which Mr. Fox made large collections, and which forms a connecting link, botanically as well as geographically, between the country I chiefly treat of, and the tropical parts of the same continent.

The Rio de la Plata, which, even as far up as Buenos Ayres, is between twenty and thirty miles wide, forms a strongly marked *geological* boundary, separating two widely extended and very dissimilar formations. All its northern shore is composed of crystalline rocks,—granite and gneiss, and their various modifications,—which range from thence to the northward, uninterruptedly, through many degrees of latitude, constituting the whole coast of Brazil to far within the tropic; it is said, even to Bahia. On the south of

the great river, nothing is seen but tertiary formations of a very late date: first, the mud and marl of the Pampas, and further south, the gravel and shingle of Patagonia. So absolute is the line of demarcation, that, while on the northern bank of the river the granitic rock is perpetually showing itself on the surface in low rocks and hillocks, on the south bank not a stone nor a pebble is to be found, and all the stone used at Buenos Ayres, for paving and other purposes, is brought from across the river. But, notwithstanding this remarkable difference in the geological structure of its two banks, the Plata does not form a *botanical* boundary-line. There are indeed several species of plants which are confined to one or the other side, and some families, principally tropical, which do not cross it; yet the leading characteristics of the vegetation, both as to its general physiognomy and its prevailing forms, are the same on both sides. The whole country, therefore, from the frontier of Brazil southward, as far as the Pampas vegetation extends (or to the border of Patagonia), may be considered as one botanical province, which, for the sake of convenience, I shall provisionally call the *Argentine* Region, from the name of the great river.

The botanical characteristics of this region are well marked. The most striking peculiarity of its physiognomy is the almost entire absence of trees, and the scarcity even of shrubs, except along the banks of the principal rivers. Every one who has come from Rio de Janeiro to Monte Video and Buenos Ayres has been struck with the contrast between the gigantic vegetation of Brazil, and the bare, treeless, almost barren character of the shores of the Plata, where the cultivated poplars, and the flower-stems of the Agave, and here and there a solitary *Ombù* tree (*Phytolacca dioica*), are the only objects that relieve the nakedness of the country. Yet the vegetation along the river-side, at least near Buenos Ayres, may almost be called luxuriant in comparison with that at a short distance inland. It is not that the vegetable covering of the soil is really scanty or meagre, but the vast majority of the plants which compose it are herbaceous, of low growth, and for the most part not very conspicuous. This treeless character of the country has been forcibly described, and its possible causes most ably discussed, by Mr. Darwin, in his 'Journal.' The immediate banks of the Uruguay and the Paranà, however, and the islands in those rivers appear to be wooded, though not with trees of great height or size.

As compared with the vegetation of Brazil, that of the Argentine region is distinguished not only by the predominance of herbaceous plants, but (as might be expected) by the diminished numbers of tropical families, and also by something of a more European physiognomy. I cannot, however, think that this resemblance of the Argentine to the European flora is as great as it has been represented by some celebrated botanists. The resemblance appears to me partly fallacious, occasioned by the abundance of *naturalized* European plants; and, excluding these, to consist rather in a certain general similarity of outward appearance than in a real botanical analogy.

Schouw, indeed, (as quoted by Meyen in his 'Geography of Plants,') says that, "out of 109 genera which belong to Buenos Ayres, 70 appear in Europe;" and St. Hilaire, a very high authority, states that, of 500 species collected by him in the Banda Oriental, between the mouth of the Plata and that of the Rio Negro, a tributary of the Uruguay,

only 15 belonged to families completely strangers to Europe. These statements are doubtless accurate, as far as they go; but the vegetation of those countries is in reality more different from the European than such comparisons would seem to imply. For, in the first place, many of the families and genera of plants which especially predominate in the Argentine region, and are strikingly characteristic of it, are such as are but scantily represented in Europe, or make no conspicuous figure here. Such are, in particular, the families of *Solaneæ*, *Verbenaceæ*, *Amaranthaceæ*, and, perhaps I may add, *Malvaceæ*. Such is the genus *Solanum*, of which many more species grow wild within a short walk of the city of Buenos Ayres, than in the whole of Europe; such is the genus *Verbena*, so insignificant in our continent, but playing so conspicuous a part in the Argentine vegetation, by the number of species, the profusion in which they grow, and the beauty and brilliancy of many of them. I may add also the genus *Eryngium*, or at least that curious section of it which is characterized by narrow and parallel-veined leaves.

Secondly, although the genera altogether wanting in Europe may not form, numerically, a very large proportion of the Argentine flora, yet several of them are very conspicuous, and play an important part in that flora by the number of species or of individuals. Such are *Pontederia*, *Gomphrena*, *Teleianthera*, *Jussiæa*, *Nicotiana*, *Petunia*, *Nierembergia*, and others.

Thirdly, on the other hand, several of the families of plants which most abound in Europe, are nearly wanting, or but very feebly represented, (if we exclude naturalized plants,) on the shores of the Plata; such are *Cruciferæ*, *Caryophylleæ*, *Umbelliferæ* (excepting *Eryngium*), *Boragineæ*, *Dipsaceæ*, and two of the primary divisions of *Compositæ*, namely the *Cichoraceæ* and *Cynareæ*.

In the collections in my possession from Buenos Ayres and the Banda Oriental, I find fourteen families and 102 genera which are not European. The families are:

Commelynaceæ,	*Marantaceæ*,	*Passifloreæ*,	*Buttneriaceæ*,	*Tropæoleæ*,
Pontederaceæ,	*Calyceraceæ*,	*Loaseæ*,	*Malpighiaceæ*,	*Melastomaceæ*.
Bromeliaceæ,	*Bignoniaceæ*,	*Begoniaceæ*,	*Sapindaceæ*,	

The *genera* wanting in Europe are the following:

Paspalum.	*Sisyrinchium.*	*Vernonia.*
Stenotaphrum.	*Cypella.*	*Stevia.*
Cenchrus.	*Alstrœmeria.*	*Baccharis.*
Aristida.	*Tillandsia.*	*Pterocaulon.*
Chascolytrum.	*Oncidium.*	*Haplopappus.*
Pappophorum.	*Canna.*	*Flaveria.*
Eustachys.	*Spathicarpa.*	*Porophyllum.*
Eleusine.	*Roubieva.*	*Leighia.*
Androtrichum.	*Gomphrena.*	*Verbesina.*
Commelyna.	*Teleianthera.*	*Achyrocline.*
Hydrocleis.	*Pupalia.*	*Trixis.*
Pontederia.	*Iresine.*	*Mitracarpum.*
Herreria.	*Acicarpha.*	*Cephalanthus.*
Udora.	*Boopis.*	*Asclepias.*

Gomphocarpus.
Oxypetalum.
Araujia (*Physianthus*, Mart.).
Philibertia.
Schistogyne.
Lantana.
Calonyction.
Nicotiana.
Nierembergia.
Petunia.
Jaborosa.
Himeranthus.
Cestrum.
Buddlea.
Scoparia?
Herpestes.
Dicliptera.
Bignonia.
Argemone.
Passiflora.
Blumenbachia.
Begonia? (There is some doubt about the locality of the specimens of this.)
Pavonia.
Sida.
Abutilon.
Buttneria.
Stigmaphyllon.
Heteropterys.
Paullinia.
Croton.
Phyllanthus.
Schinus.
Chymocarpus.
Jussiæa.
Heimia.
Cuphea.
Eugenia.
Chætogastra (*Arthrostemma*, DeC.).
Mimosa.
Desmanthus.
Inga.
Calliandra.
Acacia.
Parkinsonia.
Cassia.
Poinciana (perhaps introduced?).
Crotalaria.
Indigofera.
Tephrosia.
Daubentonia.
Desmodium.
Æschynomene.
Clitoria.
Camptosema.
Canavalia.
Galactia.
Vigna.
Erythrina (*E. Crista-galli*, perhaps introduced at Buenos Ayres).
Rhynchosia.
Machærium.

Such estimates are of course liable to some variation, according to the different opinions entertained by different botanists as to the limits of genera. In the above list I have taken Endlicher's 'Genera Plantarum' for my guide.

The above observations will show how materially the Argentine Flora differs, in reality, from that of Europe. What principally contributes to give it, at first sight, a European aspect, is the great number and extraordinary prevalence of *naturalized* European plants,—plants evidently introduced in the first instance by accident, and which, being of a hardy constitution, and possessing efficient means of propagation, have spread so rapidly as to cover the soil to a great extent, and actually to predominate over the native growth. No small proportion of the plants which a stranger will observe in his first rambles in the neighbourhood of Buenos Ayres are colonists from our quarter of the globe. The fallow fields about that city are blue with *Echium violaceum*; the banks of earth are covered with the common Fennel; the ditch-sides and waste ground are overrun with *Chenopodium album*, *Sonchus oleraceus*, and *Xanthium spinosum*; *Trifolium repens* and *Medicago denticulata* form much of the herbage near the river-side; and among the most common grasses are *Lolium perenne* and *multiflorum*, *Hordeum murinum* and *H. pratense*. What is more remarkable, these intrusive strangers are not confined to the cultivated lands or to the neighbourhood of the city, but have spread far and wide over the open plains. The "thistles" and "clover" which clothe the Pampas of Buenos Ayres for leagues and leagues together, have been described by many travellers; they are *Carduus Marianus*, *Cynara Cardunculus*, and *Medicago denticulata*, all of them European species. The two former have spread themselves also over the country north of the Plata, where M. de St. Hilaire found them covering wide tracts of country. It would seem that these temperate regions of South America are peculiarly favourable to the growth of European plants, and that

none of the native ones possess so hardy a constitution, or such powers of propagation, as these strangers. It is, as Mr. Darwin remarks, a parallel case to that of the horse and ox, which have, within the last three centuries, spread themselves in such countless numbers over the same countries.

It appears to me that this wide diffusion of naturalized plants, originally foreign to the country in which they now grow, bears in some degree upon the question of *specific centres*; or at least is adverse to the views of those who consider the natural distribution of species as determined solely by favourable local circumstances. These introduced plants have established themselves so readily and so completely, that it is quite evident, the soil, climate, and other circumstances affecting their distribution, must be highly favourable; yet they did not exist in those countries until introduced by the indirect agency of man. Therefore it would seem that they were not created indiscriminately in all the situations naturally adapted to their constitutions. But the general question of the distribution of plants is too wide for me to enter further upon it in this place.

The *social* character which is so eminently conspicuous in many of the naturalized plants above noticed is not confined to them, but is observable also, though in a less degree, in several of the indigenous plants of the Pampas of Buenos Ayres. The most remarkable in this respect, as far as I observed, are *Verbena erinoides* and *chamædrifolia*, *Mitracarpum Sellovianum*, and a dwarf *Solanum*; besides a few grasses, which, as they were not in flower at the time of my visit to Buenos Ayres, I could not determine. This social growth of some particular plants, and consequent uniformity of vegetation, has, I think, been noticed by various naturalists as characteristic of extensive plains.

Tropical forms of vegetation are not wanting in the Argentine region, but occur chiefly on the banks and islands of the principal rivers, much more rarely in the open country. They are principally woody climbers, such as *Passiflora cærulea*, *Stigmaphyllon littorale*, two or three species of *Paullinia*, a *Cardiospermum*, and a *Bignonia*; or *Leguminosæ* of a tropical character,—species of *Mimosa*, *Inga*, *Calliandra*, and *Cassia*. Of the *Melastomaceæ*, a family so eminently characteristic of tropical South America, and especially of Brazil, one solitary species (an *Arthrostemma*) reaches to the north bank of the Plata, but does not cross it. Colonia, opposite to Buenos Ayres, seems to be the most southern locality of that beautiful order. One *Machærium*, a very tropical form, grows in the islands of the Uruguay, near its mouth, and is probably the most southern representative of the *Dalbergia* tribe of *Leguminosæ*. A few Monocotyledonous genera which have their head-quarters within the tropics appear for the last time, as we go southwards, on the banks of the Plata; such are *Canna* (of which there is one species at Buenos Ayres), *Oncidium*, and *Tillandsia*.

Of the range of *Palms* in the region in question I have no knowledge. It would appear from Mr. Darwin's statements, that they occur here and there as far as 35° S. lat., which seems to be likewise their southern limit in Chile.

The southern limit of the Argentine vegetation seems to be determined mainly by soil; the northern, by climate alone. To the south its extension seems to depend upon that of the Pampean formation; that is to say, where the calcareous mud and marl of the Pampas are succeeded by the arid gravel or shingle of Patagonia, the character of the vegeta-

tion also changes. The Rio Colorado, in S. lat. 40°, was observed by Mr. Darwin to form a pretty accurate boundary-line between these two formations; and he notices* the change in the vegetable covering of the soil accompanying this change in its mineral nature. The herbaceous vegetation which clothes the surface of the Pampas pretty uniformly is succeeded by low scraggy thorny shrubs and dry meagre grasses, which, according to the accounts we possess, are so thinly scattered over the shingly plains of Patagonia, that the aspect of the whole country is strikingly barren and miserable. That this change of soil should be attended with so great a change in the vegetation, while that (more striking in a geological view) which takes place when we cross the Plata seems to have very little influence on it, is easily accounted for by the different relations of these soils to moisture. The surface of Patagonia, composed of loose shingle, is singularly dry; so much so, it is said, that one may travel for many days together without meeting with a drop of water: consequently, it is fitted for the growth of such plants only as can bear this remarkable degree of drought; and the character of the Patagonian Flora, as shown by all the accounts, is just such as we should expect under these circumstances. On the other hand, the clay and marl of the Pampas, and the soil, formed of decomposing granite, on the north side of the Plata, are both sufficiently favourable to the retention of moisture, and consequently to the growth of an abundant herbage.

To the northward, the Argentine region appears to have no very definite boundary, but to melt, as it were, into that of southern Brazil. About Porto Alegre, in Rio Grande do Sul, in S. lat. 30°, and consequently little more than four degrees north of Buenos Ayres, the botany has a thoroughly Brazilian character, notwithstanding the absence of great forests. There are abundance of large and showy climbers of a tropical aspect,—species of *Bignonia*, *Echites*, *Malpighiaceæ*, *Sapindaceæ*; of arborescent *Mimoseæ*; of shrubby *Compositæ*, belonging to the same genera, *Vernonia*, *Eupatorium* and *Baccharis*, which abound so much in tropical Brazil; and a vast profusion of Myrtles. The numerous Ferns of Rio Grande are almost all common to that district and Rio de Janeiro, and among them are two arborescent species, which contribute to give a tropical character to the Flora. Not a few phænogamous species, also, extend from the tropical parts of the South American continent as far as Porto Alegre; for example,—*Inga semialata*, *Mutisia speciosa*, *Baccharis dracunculifolia*, *Gaylussacia imbricata*, *Echites longiflora*, *Pleroma virgatum*, *Microlicia alsinefolia*, *Eryngium Pristis*, *Eriocaulon caulescens*; besides others which range still further south, to Monte Video, such as *Baccharis trimera*, *Pterocaulon spicatum*, *Achyrocline flaccida*, *Hydrocleis Humboldtii*, and various grasses.

On the other hand, the comparatively small number of *Melastomaceæ*, and the abundance of herbaceous and half-shrubby *Verbeneæ*, in Rio Grande, indicate the approach to the Argentine region. Some, indeed, of the characteristic species of Buenos Ayres, such as *Verbena erinoides* and *chamædrifolia*, range northwards as far as Porto Alegre. The considerable degree of difference between the vegetation of this latter place and of the northern shore of the Plata must, I conceive, be due to climate only, for there exists no natural barrier, and, as far as I can learn, there is no difference in the geological constitution of the country. I possess no precise information with respect to the climate of

* See Darwin's Journal of Researches, 2nd edit. p. 75.

Porto Alegre; but the fact mentioned by M. de St. Hilaire *, that the cultivation of mandioca and sugar extends so far south, and no further, seems to point it out as the southernmost limit of the seasons of tropical Brazil. Mr. Darwin has remarked the rapid change of climate in proceeding northward from Buenos Ayres, and in accordance with this, apparently, is the change of vegetation.

It would be interesting to compare the Flora of Chile with that of the Argentine region, but for this I have not sufficient materials. Meyen, in his 'Geography of Plants,' says that Chile and the countries on the eastern side of the Andes, in corresponding latitudes, cannot be considered as separate botanical regions; yet the information which he himself gives, in the same work, as to the Chilian Flora, seems to show that its general physiognomy is very different from that of the Argentine region. The accounts of many travellers show us that the climate and soil of Chile, in the latitudes of which I treat, are much more dry than those of the countries near the Plata, and this cannot fail to be attended with a considerable difference in the vegetation. The Chilian Flora, by Meyen's account, appears to be as strikingly characterized by dry shrubs with coriaceous and glossy leaves, as that of the Plata is by the prevalence of herbaceous forms. In the abundance of Myrtles, indeed, and of shrubby and arborescent *Compositæ*, the vegetation of Chile may be compared rather with that of southern Brazil. At the same time, the valuable catalogues drawn up by Sir W. Hooker and Dr. Walker-Arnott † show that many remarkable genera, and not a few species, are common to both sides of South America.

The Argentine Flora has little or no *general* analogy to that of the southern parts of North America lying in corresponding latitudes on the other side of the equator; yet there are some striking, though insulated, points of resemblance. There is a species of *Cephalanthus* on the shores of the Plata; there is an *Æschynomene* (*Æ. ciliata*, Vog.), excessively like the North American *Æ. hispida*; a *Pontederia*, extremely near to *cordata*, if not a mere variety of it; a *Sisyrinchium*, much resembling *S. Bermudianum*.

If we compare the Flora of the shores of the Plata with that of the Cape of Good Hope lying within the same parallels of latitude and having nearly the same mean temperature, we find an extraordinary difference between them. The many points of analogy, and the general physiognomical resemblance, between the vegetation of the Cape and of New South Wales have repeatedly been noticed; but between the botany of the Cape and that of La Plata we find scarcely anything but contrasts. It is not easy to discover any points of resemblance. The general physiognomy of the vegetation is different: the plants of the Argentine region are chiefly herbaceous, while at the Cape there is a great predominance of dry, hard, small-leaved shrubs. Almost all the characteristic families and genera of the two Floras are different: the *Solaneæ, Verbeneæ, Amaranthaceæ, Calyceraceæ, Helianthoid Compositæ, Pontederias, Jussiæas, Eryngiums*, and other forms which make up the most important part of the vegetation on the shores of the Plata, are wanting or insignificant at the Cape, which, as is well known, is characterized by *Proteas, Heaths, Diosmas, Pelargoniums, Mesembryanthemums, Aloes, Crassulaceæ*, and *Restiaceæ*; all of them absent, or nearly so, from the region of which I here treat. *Leguminosæ* are abundant in both countries, but for the most part of different genera. Almost the only points

* Journal, 2nd edit. p. 128.

† See the Botanical Miscellany, vol. iii.

in the Argentine Flora which strongly remind us of South Africa, are several species of *Oxalis*, and some gay-flowered *Irideæ* and *Amaryllideæ* (*Cypella Herberti*, *Sisyrinchium Bonariense*, species of *Habranthus* and *Zephyranthes*), which decorate the banks of the Plata. The *Cacteæ* of the latter country are represented at the Cape by succulent *Euphorbias*; and the herbaceous and half-shrubby *Malvaceæ*, which are numerous at Buenos Ayres, have South African representatives in the *Hermanniæ*.

Another thing which strikes us when we compare the Flora of Buenos Ayres with that of the Cape of Good Hope is, that the former is much less peculiar in its character than the latter. The Argentine region, considered botanically, is recognized at once as a province of South America; all its characteristics are such as belong especially to that part of the world, while the botany of the Cape has little resemblance to that of the rest of Africa. The distinction will be very apparent, if we compare, on the one hand, the Flora of the Plata with that of tropical Brazil, and on the other, the Cape Flora with that of tropical Africa. The number of peculiar or *endemic* genera of plants in the Argentine region is comparatively very inconsiderable; at the Cape, remarkably large. The peculiar genera of the former region almost always consist of a single species, or of very few; several of the peculiar Cape genera are very rich in species. The number of species common to the shores of the Plata and the tropical parts of the same continent is considerable, while extremely few are common to the Cape and tropical Africa.

A part of these differences may be accounted for by the local circumstances of the two countries. The Cape of Good Hope, as a botanical region, is almost cut off from the rest of Africa by the great deserts which, to the north of the Orange River, stretch across so great a part of the continent. Even in the colony itself, the desert called the Great Karroo is known to set an absolute limit to the northward extension of several characteristic families *. Now there is no barrier of this sort on the eastern side of South America, where (excepting perhaps the case of Patagonia) the limits of the range of plants seem to be fixed by climate alone. Moreover, it is probable that the characteristic Cape plants, generally speaking, are of a more delicate constitution, and have less power of bearing change of circumstances, than those of Buenos Ayres; as may be inferred from the much greater difficulty of cultivating them in gardens.

Another difference that I may notice, between the Cape of Good Hope and Buenos Ayres, is that naturalized European plants do not play by any means so conspicuous a part in the botany of the former country as in that of the latter. A good number of introduced species have indeed established themselves in the neighbourhood of Cape Town, but they have not spread far, nor do they appear in any remarkable quantity, nor at all vie with (much less supersede) the original natives of the soil. It is not owing to the greater extension of European culture that these plants have been more widely diffused in the region of the Plata; for although a great part of that country might probably be found very fit for cultivation, the proportion of it which has actually been brought into that state is very minute indeed. The climate, from its greater moisture, may be more favourable to such plants than that of the Cape, but the chief cause of the difference is probably to be found in the soil.

* See Burchell's Travels.

Mr. Brown has indicated a few points of resemblance between the botany of Australia and that of the temperate parts of South America; but these all, I think, belong to Chile. On the eastern side of the continent, within the latitudes in question, I am not aware of any plant that can at all remind us of the Australian Flora. It is rather remarkable, that the *Protea* family, which occurs, though sparingly scattered, in Fuegia, Chile, Peru, Guiana, and tropical Brazil, seems to be entirely absent from the region of which I treat.

I shall conclude with a few remarks upon some of the families contained in the collections before me, and on the range of particular species.

Filices.—At Porto Alegre and one or two other points in the extreme south of Brazil, about 30° S. lat., Mr. Fox collected fifty-four species of Ferns. This collection strongly exemplifies the wide range of species in this family, pointed out by Sir W. Hooker and by Dr. Joseph Hooker; for nearly the whole are natives of tropical Brazil, and at least one-half of the number occur likewise to the north of the Equator,—in the West Indies, Caraccas, Guiana, or Mexico. Two extend even to Europe,—*Asplenium marinum* and *Osmunda regalis*. The Rio Grande specimens of this *Osmunda* agree perfectly with the ordinary British form.

Of the fifty-four Ferns, forty-nine belong to *Polypodiaceæ**; two to *Gleicheniaceæ*, two to *Schizæaceæ*, and one to *Osmundaceæ*. Two are arborescent, *Didymochlæna sinuosa* and *Alsophila armata*. This, I suppose, is the southernmost limit of Tree Ferns on the eastern side of South America.

Buenos Ayres is remarkably poor in this family of plants. During the month that I spent there, although I paid much attention to botany, I did not observe a single Fern; and in the collections made by Mr. Fox, who, I know, took particular interest in this family, I find only one† Fern from the south side of the Plata. This circumstance is not at all surprising, for the bare, level, shadeless, treeless plains of Buenos Ayres are peculiarly unsuited to the Ferns. And we may observe, that even where there is a warm climate and a tolerably large supply of atmospheric moisture, (for both these conditions exist at Buenos Ayres,) these plants do not seem to flourish unless there be shade and variety of surface. In accordance with this, is the absence of Ferns from the bare table-land of Mexico‡, and their great scarcity on the open *campos* of the interior of Brazil. The neighbourhood of Graham's Town, in South Africa, has a much drier climate than Buenos Ayres, yet the ravines and rocks there, affording shade and shelter from the wind, produce many Ferns.

Gramina.—Among the Grasses collected on the banks of the Uruguay and La Plata, I find the *Poaceæ* (according to the division established by Mr. Brown) to be rather more numerous than the *Paniceæ*; the former, however, including a few naturalized species. The comparatively small number of Grasses in the collection does not allow me to suppose that it is, in this respect, at all a fair representative of the vegetation of the Argen-

* I follow the arrangement of Mr. J. Smith, published in Hooker's Journal of Botany.

† This is a *Blechnum* (or *Lomaria*? for Mr. Fox's specimens have no fructification) which seems to agree with the description of *Blechnum auriculatum*, Cav.

‡ See Martens and Galeotti, Fougères de la Mexique.

tine region, the local conditions of which appear favourable to this family. I will therefore not attempt to estimate the proportional number of Grasses to other orders. I will merely observe, that, besides some European grasses evidently naturalized in that region*, there are some apparently indigenous species which have a very wide range. Such are *Cynodon dactylon*, which seems to be a native of all the warmer parts of the world, in both hemispheres; *Setaria glauca*, equally cosmopolite; *Setaria italica*, of which I have specimens from Louisiana as well as from the Uruguay, and which is stated to be a native of Europe, India and New Holland; *Eleusine indica*, which appears, from the localities given by Kunth, to have a vast range in the tropical and subtropical zones; *Polypogon monspeliensis*, which I have myself seen at the Cape of Good Hope and at Buenos Ayres, as well as in the south of Europe; *Stenotaphrum glabrum*, common to the Cape, Louisiana, tropical Brazil, and the northern shore of the Plata. The beautiful grass *Eustachys petræa* may be added, if the Cape plant be really the same with the South American, which does not seem quite certain.

Eriocauloneæ.—Of this family, so very numerous in tropical South America, and especially in the interior mountainous districts of Brazil, I find only one species in Mr. Fox's collections from the extreme southern part of that country. This is *Eriocaulon* (*Pæpalanthus*) *caulescens*, of which there are specimens from Porto Alegre, S. lat. 30°; I met with it in Minas Geraes, not far from S. Joao d'El Rey; and I have seen a specimen from Guiana in Sir J. E. Smith's herbarium.

Alismaceæ.—A fine species of *Sagittaria* is plentiful in the marshy pools near the riverside at Buenos Ayres; it is, I suppose, *S. Montevidensis* of Chamisso†, though it differs from his specific character in having the back of the leaf quite smooth. It certainly comes very near to *S. sagittifolia*, though much larger both in the leaves and flowers. The *downy* filaments of the stamens, and *yellow* anthers, seem, as far as I can judge, to furnish the most certain characters; for the leaves of our English Arrow-head are so very variable, that it is hardly safe to rely upon the distinctions afforded by their more suddenly and sharply acuminated lobes in the Buenos-Ayrean plant.

Compositæ.—The celebrated botanist, Schouw, has characterized the countries near the Plata as the "Kingdom of Arborescent *Compositæ*;" a title scarcely applicable, for these plants, like most others of the region in question, have for the most part a herbaceous character.

Here, as in South America generally, the *Compositæ* appear to be the most numerous family of plants; but I am not able to state their proportional numbers with precision. Almost all those of the Argentine region belong to the *Corymbiferæ* of Jussieu; the *Cichoraceæ* and *Cynareæ* hardly occur at all, except in a naturalized state. The *Labiatifloræ*, so characteristic of the western side of South America and of the Andes, are few and inconspicuous in this region. It is curious, that the genus *Mutisia*, which ranges all up the west side of the continent from southern Chile into New Granada, and is scattered also through Brazil, as far south as Porto Alegre, does not seem to extend to the Plata. I must own, however, that negative conclusions in such cases are a little uncertain, unless they rest upon the concurrent testimony of many observers.

* See before, p. 188.

† Kunth, Enumeratio Plantarum, vol. iii. p. 157.

The shores of the Rio de la Plata are characterized by many herbaceous *Helianthææ*:—species of *Leighia*, *Verbesina*, *Bidens*, &c. The genera *Vernonia*, *Baccharis* and *Eupatorium*, so characteristic of tropical Brazil, extend into this region, but no longer in such amazing numbers. At the Cape of Good Hope, where the abundance of *Compositæ* is remarkable, the prevailing groups are for the most part different from those of Buenos Ayres; in particular, the Everlastings (*Helichryseæ*), so prodigiously numerous at the Cape, are comparatively scarce in the corresponding latitudes of South America. The universal genus *Senecio*, however, abounds in both countries.

It has been observed, that the species of this family have not in general so wide a geographical range as might have been expected, considering the facilities for dissemination afforded by their feathered seeds. Nevertheless, several of the *Compositæ* of the Plata are tropical species, and some even common to both hemispheres. *Bidens helianthoides*, a common marsh plant at Buenos Ayres, appears to be a native of Mexico, Guiana, and Chile. *Flaveria Contrayerba* is common to Buenos Ayres (Mr. Fox), Peru, and Mexico. *Achyrocline flaccida*, common at Rio de Janeiro, was observed by Mr. Fox to range all the way from that place to the north bank of the Plata, and was also found by Schomburgk in Guiana. *Gnaphalium Gaudichaudianum*, another native of Rio, is in Mr. Fox's collection from Monte Video. *Pterocaulon spicatum* appears to have much the same range as *Achyrocline flaccida*: I have specimens from British Guiana, Rio de Janeiro, Rio Grande, and Maldonado *. The first and last of these stations are separated by about thirty-seven degrees of latitude. *Baccharis trimera*, DeC., also appears to be widely diffused in South America: it is one of the most common plants all the way from the gold district of Brazil to the Serra da Estrella near Rio †; it has been found at Bahia and at St. Catherine's; Mr. Fox met with it at Monte Video as well as in Rio Grande; and it is probably the same species that is mentioned by Sir W. Hooker ‡ as found by Dr. Gillies in the Pampas of Buenos Ayres, and by Tweedie in Northern Patagonia. All these, however, are instances of diffusion in latitude: I have not found among the *Compositæ* of the Argentine region (excluding evidently naturalized plants) any that are common to more than one continent.

Asclepiadeæ.—This order is numerous in Rio Grande and the Argentine region, as it seems to be in South America generally, although these countries by no means rival the Cape of Good Hope in the abundance of Asclepiads. One species, the *Gomphocarpus fruticosus*, widely diffused over the warmer parts of the old world, occurs also, I believe, at Monte Video; at least the specimens gathered there appear to me undistinguishable from the Cape plant; but it may have been accidentally introduced to this locality. With the exception of this genus and *Cynanchum*, the Asclepiads of Rio Grande and the Plata all belong to strictly American forms, among which *Oxypetalum* predominates in number. I find in Mr. Fox's collection only one species of *Asclepias* (*A. citrifolia*?); the *A. Curas-*

* The specimens from Maldonado have narrower and more pointed leaves than the others, but Sir W. Hooker named them *Pt. spicatum*, without any indication of doubt.

† It is certainly the *B. genistelloides* of Spix and Martius's 'Travels in Brazil.' Is it really distinct from the true *B. genistelloides*?

‡ Journ. Bot. vol. iii. p. 42.

savica, so common on the coasts of tropical Brazil, does not, apparently, extend much beyond the tropic.

Umbelliferæ.—These plants, observed by Humboldt to be very rare within the tropics, unless at great heights, seem to be pretty numerous in the subtropical zone of the southern hemisphere, but mostly of rather peculiar forms. The *Umbelliferæ* of La Plata and Rio Grande belong chiefly to the genus *Eryngium*, and especially to that curious section of it with long, narrow, linear or sword-shaped, parallel-veined leaves (or *phyllodia*), which are often fringed with bristles, or with bristle-like teeth. In Mr. Fox's collections from those countries, I find nine species of *Eryngium*, of which five belong to the parallel-veined section. One of them (*E. aquaticum*?) is a stately plant, 5 or 6 feet high, a conspicuous ornament of the marsh ditches near Buenos Ayres, with leaves that remind one of a *Bromelia* or *Pandanus*. Another (seemingly *E. Pristis*) extends from the tropical regions of Brazil as far as 30° S.; it is very frequent on the *campos* of Minas Geraes (about 20°–21° S.), at the elevation of 2000 to 3000 feet, while in Rio Grande Mr. Fox seems to have found it at a comparatively low level. Many *Eryngiums* of the same group, and, as it appears, nearly allied to these South Brazilian kinds, were found by Humboldt and Bonpland on the high lands of Mexico, and there are several in Chile.

I find very few other *Umbelliferæ* from the Argentine region in the collections before me. This part of South America seems to be destitute of those curious *Mulineæ* (*Bolax*, &c.) which are so characteristic of Fuegia, the Chilian Andes, and the Falkland Islands.

At the Cape of Good Hope, in corresponding latitudes, we find very different forms of this, as of most other families. That country has no *Eryngiums*, and I believe only a solitary representative of that division of the order, the *Alepidea ciliaris*. It has, however, a considerable number of *Umbelliferæ*,—not less than 120 species, according to Harvey,—and among them several peculiar genera, of which *Hermas* and *Arctopus* are the most singular; likewise many remarkable forms of *Hydrocotyle*, which seem in a manner to represent the South American *Mulineæ*.

Several European *Umbelliferæ* have become naturalized at Buenos Ayres, and among these the common Fennel is extremely conspicuous, covering the banks of earth between the cultivated fields in immense profusion, and forming a distinctive feature in the scenery. I have heard it remarked, by residents in that city, that when the wind called the Pampero, which blows over the inland plains, is coming on, its approach is always announced by the smell of *Fennel*, which it brings from the beds of this plant that it passes over. Mr. Darwin observed the range of the Fennel to be limited on the south by the Rio Salado, rather less than 100 miles south of Buenos Ayres.

Malpighiaceæ.—This is one of the characteristic tropical American orders which die out rapidly in proceeding towards temperate latitudes. Two species only, as far as I know, are found on the south side of the Plata, namely *Stigmaphyllon littorale* and *Heteropterys glabra*. In Rio Grande, Mr. Fox collected nine *Malpighiaceæ*, of which one is a *Galphimia*, the rest belong to *Banisteria*, *Stigmaphyllon*, and *Heteropterys*.

Tropæoleæ.—*Tropæolum* (*Chymocarpus*) *pentaphyllum*, abundant in the hedges about Buenos Ayres, seems to be the only plant of this order on the eastern side of temperate South America. Its head-quarters are evidently on the western side of the continent.

Œnothereæ (Endl.).—Of the four principal genera of this family, *Jussiæa*, *Œnothera*, *Epilobium* and *Fuchsia*, the Argentine region possesses only the first two. Some species of *Jussiæa* are plentiful on the marshy shores of the Plata, but as the genus has its head-quarters within the tropics, so it is richer in species at Porto Alegre than at Buenos Ayres. From this latter place I possess three species of *Œnothera*. *Fuchsia*, so characteristic of the west side of South America, seems, on the eastern side, to be confined to *tropical* Brazil.

Melastomaceæ.—One species only (as I have already mentioned) extends as far south as the Rio de la Plata, but does not appear on the southern bank of that river. Even in Rio Grande, the plants of this order are few when compared with their abundance in tropical Brazil, and when compared also with the allied family of Myrtles. I am aware of only nine species from the southern extremity of Brazil.

Leguminosæ.—The Argentine region is not particularly rich in these plants; at least, they by no means form so important a part of the vegetation as in tropical Brazil, in the south of Europe, or in Australia. The *Leguminosæ* of the region in question belong, with few exceptions, to genera widely diffused, such as *Crotalaria*, *Lupinus*, *Tephrosia*, *Indigofera*, *Desmodium*, *Æschynomene*, *Lathyrus*, *Clitoria*, *Cassia*, *Mimosa*, *Inga*, *Acacia*. This is quite a contrast to what is observable at the Cape of Good Hope, where the number of peculiar or *endemic* genera of this order is remarkably great. The observation which I have already made, as to the small number of peculiar forms in the Argentine Flora, when compared with that of the Cape, is particularly exemplified in this important family. The same holds good, perhaps in a still greater degree, if we compare it with the Flora of corresponding latitudes in Australia. It may be observed, also, that the greatest part of the *Leguminosæ* of the Plata belong to genera which are principally tropical, and which only straggle, as it were, into cooler latitudes; such are all but two, or perhaps three, of the genera mentioned above, One is almost tempted to say that the vegetation of this region is a mere modification, a reduced or dwindled form, of the Brazilian, instead of being a separate and strongly marked Flora like that of the Cape.

Again, at the Cape, the *Loteæ* predominate remarkably over the other papilionaceous tribes; in the region of the Plata, the *Hedysareæ* and *Phaseoleæ* are at least equally numerous. *Cæsalpineæ* and *Mimoseæ* are more numerous on the banks of the Plata than in the same latitudes in South Africa. In that country, south of the Orange River, I know of only two species of *Acacia*, although these are so abundant (one of them especially) as to give a distinctive character to the scenery; nor, as far as I am aware, are there any other *Mimoseæ* south of the same river, although, to the north of it and at Natal, (about the latitude of the southern extremity of Brazil,) they become numerous. Mr. Fox's collections from Buenos Ayres and Uruguay (between 33° and 35° S. lat.) include five species of *Mimosa*, one of *Desmanthus*, two of *Calliandra*, and five of *Acacia*; yet none of these are so abundant as to form characteristic features of the country, like the *Acacia horrida* and *Caffra* in the eastern part of the Cape colony. The *Cæsalpineæ* of these latitudes are principally *Cassiæ*, of which there are several species at Buenos Ayres. The magnificent *Poinciana Gilliesii* is said not to be indigenous there, though now well established on the banks of the Plata.

Daubentonia punicea, stated by Cavanilles to be a native of "New Spain," was observed by Mr. Fox to grow wild, sparingly, on the bank of the Rio de la Plata, below Buenos Ayres, and in great abundance and beauty on the banks of the Uruguay, near its mouth. It is certainly quite possible that the plant may be common to both countries, but it is also, I think, possible that Cavanilles, who saw it only in a botanic garden, may have been misinformed as to its native country, and that the Argentine region may have an exclusive claim to it.

Several European *Leguminosæ* are naturalized at Buenos Ayres; they are chiefly *Trifolieæ*, in particular *Medicago sativa* and *denticulata*, *Trifolium repens*, *Melilotus parviflora*.

Indigofera Anil, apparently a general plant thoughout the hotter parts of America, was observed by Mr. Fox to be common all through South Brazil and the Banda Oriental, but not to occur south of the Rio de la Plata. *Æschynomene ciliata* ranges at least from Guiana to Buenos Ayres, and, as Mr. Bentham observes, it is scarcely distinguishable from the North American *Æ. hispida*, which is found as far north as Philadelphia. Another *Æschynomene*, from Buenos Ayres, seems to agree with the *Æ. conferta* from British Guiana.

XXI. *On the Genus* Aquilaria. *By the late* William Roxburgh, *M.D., F.L.S. &c.; with Remarks by the late* Henry Thomas Colebrooke, *Esq., F.R.S., F.L.S. &c. Communicated by* Robert Brown, *Esq., D.C.L., F.R.S., President of the Linnean Society.*

Read February 18, 1851.

Aquilaria, Lamarck, Encycl. i. 49. Gen. Pl. ed. Schreb. N. 1753.

Decandria Monogynia.

Sect. *Flowers incomplete.*

Gen. Char. Calyx campanulate, 5-cleft. Corol none. Nectary 10-leaved, alternate with the stamina. Capsule superior, 2-celled, 2-valved. Seed solitary. Embryo inverse, without perisperm.

1970. Aquilaria Agallocha, Roxb. [Fl. Ind. ii. p. 422.] Leaves lanceolar. Umbels solitary, subsessile, between the leaves.

Agallochum, or *Aloe-wood* tree.
Aguru, the Sanscrit name of its precious wood.
Aggur, Uggor, Agor, &c., its Hindi and Bengali names.
Agha-loo-chee, Agalugi, Agulugin, Yelunjooj, its Arabic names.
Owd and *Owd-hindee* of the Persians.

The tree which I am about to describe (from young ones growing in the Botanic Garden at Calcutta), and which, when of age, produces at least a variety of that ancient and precious aromatic, called Aloe-wood, is a native of the mountainous districts to the east and south-east of Silhet *, the most easterly province of Bengal, in about lat. 24°–25° N.,

* Extract of a letter from Robert Keith Dick, Esq., the Judge and Magistrate at Silhet, to Dr. Roxburgh, dated Silhet, 9th December, 1808:—

"I am much obliged by your affording me the perusal of the accompanying account of the *Aggur* tree; and in returning it, I take the opportunity of giving you such information on that subject as I was able to obtain lately on a short interview with a landholder in this district, who employs his own ryuts in procuring *Aggur* wood in the hills adjoining his property, and is himself concerned in the trade of it; and as it was hastily committed to paper, previous to my reading the enclosure, it may prove so far satisfactory, in as far as some of the particulars nearly correspond.

"The wood is brought here for sale from the country of Kuchar, and from the southern parts of this Zillah, particularly the divisions of Puthureea and Lunglah. The tree is known in the hills here by the Bengal name, *Tuggur*. Its extreme height is from sixty to seventy haths (cubits), and the trunk from two to two and a half haths in diameter. The general height of a full-grown tree is from twenty to thirty haths †. Excepting that part of the wood which is reserved for the extraction of the *Uttur*, the rest is useless,—at least never applied to any purpose in this district. I have not been able to procure any information about the flower, or seed of the tree; they say neither have been seen here. This is perhaps owing to the people going to cut the wood chiefly at one period of the year, viz. the dry season. It is a precarious and tedious business procuring the wood which yields the *Uttur*, as few trees con-

† To the branches must be meant.

where, by various accounts, they attain to a very great size,—as much as about 120 feet in height, with a trunk of above 12 feet in circumference. Accounts from Assam make it still larger. Flowering-time, in its native soil, uncertain; but in this Garden a very healthy young tree, out of several that were sent to it some years ago by Mr. Robert Keith Dick, the Judge and Magistrate at Silhet, was in flower in March and April last, and again in April 1810.

Desc. Trunk (in our young trees) straight, and clothed with thin, smooth, ash-coloured tough bark. Branches nearly erect, with their terminal, bifarious, alternate, extreme twigs recurvate, bark of the branches light grey, with many small ferruginous fissures; young shoots clothed with white, soft, appressed hairs. Wood white, very light, soft and porous. Specimens from large trees in their native soil are also uncommonly soft and light, with a slight tinge of yellow, and not unlike the softest porous deal; every part inodorous, and nearly tasteless. The moisture (for nothing like exudation is found here) scraped from a fresh-cut twig was rubbed on the eye and eyelids of a chicken, without producing any inflammation or apparent irritation. This does not accord with what Father Camellus says of the true *Agallochum* tree, viz. "The bark is filled with virulent, milky juice, so very caustic as to cause blindness if it gets into the eye," &c. I can well believe the pale milky juice of *Excœcaria Agallochum* very capable of doing injury to tender parts, and probably our reverend traveller may have lighted upon that tree, which was said to yield an inferior sort of *Agallochum*. Leaves alternate, bifarious, short-petioled, lanceolar, firm and smooth, lucid deep green, except while very young, then somewhat sericeous, which is more conspicuous underneath, taper acute pointed; entire waved margins; length from 3 to 6 inches, and from 1 to 2 inches broad. Veins nearly as fine as in *Calophyllum Inophyllum*. Petioles very short ($\frac{1}{6}$ or $\frac{1}{8}$ of an inch), rugose, and a little hairy. Stipules none, except an opposite, oblong, hairy scale or two at the base of the most tender axillary shoots, like those of a gem, or bud. Inflorescence simple, solitary, subsessile, beautiful, small, spherical umbels, at nearly equal distances between or from the leaves (internodes). Flowers numerous (20–40 to the umbel), pedicelled, small, pale greenish yellow, inodorous. Bracts none. Calyx 1-leaved, campanulate, permanent, half 5-cleft; segments

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tain any; and such as do, have it very partially distributed in the trunk and branches. The people employed in this business proceed two or three days' journey among the hills, jungles and mountains, and without discrimination cut down the trees as they are found, young, old and withered, but the latter are generally preferred; they then, on the spot, search for the *Aggur*, which is done by chopping off the bark, and into the wood, until they observe dark-coloured veins, yielding the perfume which guides them to the place containing the *Aggur*, and which generally extends but a short way through the centre of the trunk or branch. In this manner they search through the whole tree, and bring away only such pieces as contain the oil, or have the smell of it. In this state there are four denominations, viz.

1st. *Ghurkee* (sinks)................	which sells from	12 to 16	rupees per seer (of 2 lbs.),
2nd. Has no other name than *Doim*....	ditto	6 to 8	ditto
3rd. *Simula* (floats)	ditto	3 to 4	ditto
4th. *Choorum* (small pieces, which float)	ditto	1 to 1½	ditto

"The tree grows in sandy as well as clayey soils, on plains, and on the sides and tops of the hills; neither root, leaves nor bark yield any *Uttur*. Some trees will produce a maund (80 lbs.) of the four sorts. The oil is obtained by bruising the wood in a mortar, and then infusing it in boiling water, when the *Uttur* collects itself on the surface."

ovate, obtuse, spreading. Corol none. Nectary of 10, oblong, obtuse, hairy scales, which are inserted into the mouth of the tube of the calyx, alternate with the filaments, slightly incurved, so as to form a dome over the germ, its mouth being shut up with the stigma. Filaments 10, shorter than the nectarial scales, coloured reddish at top. Anthers erect, oval, 2-lobed. Germ superior, ovate, smooth, 2-celled, each cell containing a single oblong ovule, attached to the partition above its middle. Style short and thick. Stigma large, glandular, obscurely 2-lobed. Capsule drupaceous, clavate-turbinate; length rather above an inch, and the diameter about half the length; of a soft fleshy texture, and villous over the surface, like a peach; colour olive-green, its contracted base embraced by the permanent calyx; 2-valved, opening round the apex (like the envelope of the nutmeg); 2-celled, partition opposed to the valves: one of the cells is generally abortive. Seed solitary, oval, with a large, straight, spongy, pointed horn from the base, which is about as long as the body of the seed. Integuments 4. Exterior, while recent, soft and white, when dry, dark brown and villous on the outside. It is a continuation of this envelope which forms the horn of the seed; on the inside a vertical, brown groove, in which the filiform umbilical cord is lodged, which connects the apex of the horn to the top of the partition; second, while recent, thick, and hardened at the base only, which is pointed and projects a little into the spongy horn; when dry, dark brown, smooth, hard and brittle; on its inside a slight groove is also observed, corresponding with that of the exterior integument; third, soft, brown, and rather spongy; fourth, or innermost, a thin pearl-coloured membrane adhering to the embryo. [*Note.* The last two not easily detected in the fresh seed, but when dry very conspicuous.] Perisperm none. Embryo inverse, when dry very pale yellow. Cotyledons conform to the seed. Plumula 2-lobed. Radicle subrotund, superior.

The foregoing is a faithful description of the tree which blossomed in this Garden in March and April 1809 and 1810. And that of the pericarpium and seed is not only taken from that which the same tree produced, gathered with my own hand, but also from some seeds which Dr. Buchanan sent from Goolparah, on the banks of the Megna or Brachmaputra, to Sir John Royds, who obligingly parted with them to enable me to render my account of this interesting tree more satisfactory; and again in 1810, from Mr. Richard Matthew Smith, of Silhet, gathered from a tree growing in his own garden at that place.

At present it is not possible for me to affirm that this is the tree which produces the real *Calambac* or *Agallochum* of the ancients, but there seems more reason to think it went to the westward from our eastern frontier, than to suppose it was carried from Cochin China, or any other country in the vicinity of China, where it has always been held in the highest estimation. Small quantities are sometimes imported into Calcutta from the eastward; but such is always deemed inferior to that of Silhet.

There is a wonderful agreement between the various but imperfect accounts of the trees said to produce this valuable drug, and that which I have now described and figured.

Lamarck's description of the specimen * presented to him by Sonnerat agrees almost

* *Garo de Malacca,* Lamarck, Encycl. i. 49.

exactly with our plant. The inflorescence is only required to confirm their being the same species, or different. Of their belonging to the same genus there can be no doubt *.

Cavanilles describes and gives a figure of the *Garo de Malacca* of Lamarck, in his Seventh Dissertation on the Plants of the Class Monadelphia, page 377. t. 224, under the name *Aquilaria ovata*, which is continued by Willdenow in his edition of the 'Species Plantarum' of Linnæus, vol. ii. p. 629. His description differs little from that of Lamarck, and his figures, so far as they go, agree uncommonly well with our subject.

I have not ventured to quote *Agallochum secundarium* (Rumph. Amb. ii. 34. t. 10), though much inclined to think they are the same. His description and figure of the specimens he received under the name *Agallochum malaccense*, so far as they go, agree as well with our tree as can be expected, and as well as the generality of the figures in that work do with the plants they are intended to represent. We must, however, suppose the fruit inverted in his plate; which is the more excusable, as it was not growing on, or naturally attached to the branch the figure is taken from, but tied to it.

Kæmpfer, that most accurate writer, in his 'Amœnitates Exoticæ,' page 903, gives a figure and description of the small plant of the *Agallochum* tree, which with great difficulty he obtained from distant mountains, under the name *Sinkoo*, both of which agree exactly with some young plants of nearly the same size (lately sent from Goolparah by Dr. Buchanan, and from Silhet by Mr. Smith) now growing in this Garden, even to every one of the plants being uniformly divided into two little branches, which with their leaves have the precise appearance of Kæmpfer's figure.

About the time that Kæmpfer made his voyage to Japan, our countryman, Mr. James Cunningham, was employed by the English East India Company on the coast of China, where he must have seen the fruit of this tree, which he describes so well, viz. "turbinate, villous, size of a yellow *Myrobalan*, with a thick cortex, opening into two, and containing two seeds separated by a partition, with membranaceous appendages (probably what I call the horn), and resting on a five-parted calyx." Until Gærtner's work appeared, this would have been reckoned a full and accurate description of the seed-vessel of my *Aquilaria Agallocha.*

Loureiro's *Ophispermum sinense*, 'Flora Cochinch.' p. 344, is no doubt another species of the same genus, and if he, or his editor, had omitted the words "flos terminalis, solitarius," I should have concluded they were the same; and unreasonable as it may appear, I must also remark, that I think, whoever reads with attention, and compares with this, his account of the nature and production of Aloe-wood in the 'Memorias de Academia Real das Sciencias de Lisboa,' vol. i. p. 402–415, will find a striking similarity in many respects, viz. size and habit of the tree; smoothness and fibrous texture of the bark, of which paper is made in both countries; shape, texture and appearance of the leaves; in

* Since writing the above, Dr. Roxburgh has received living plants, and perfect capsules with their seeds, of the *Garo de Malacca*, from Captain Farquhar, the Governor of Malacca. They are not to be distinguished from some plants of the same size, and seed-vessels of his *Aquilaria Agallocha*, very lately sent to this Garden by Mr. Smith from Silhet, a proof next to positive of their being the same: for positive proof we must wait till the Malacca plants flower, or till specimens in flower, which Captain Farquhar has promised, are procured.

G. Jarman sc.

the want of odour and taste in every part thereof, except the drug itself; in no part of the tree being lactescent or poisonous; in the wood being white, light and porous, &c. &c. I place little confidence in his description of the parts of fructification, as he acknowledges, in Willdenow's edition of his 'Flora Cochinchinensis,' to have only once seen a mutilated branch of the tree in flower, which by long carriage had the petals, anthers and stigma much bruised and torn. And if the natives of Cochin China are not more honest than in most other parts of South Asia, they would not scruple to give him the fruit of any other tree for that of his *Aloexylum*. I am therefore not much inclined to give any great degree of credit to the natural character of a plant wrote under such circumstances, and rather think the tree which produces the Aloe-wood of Cochin China, and the *Aggur* from the vicinity of Silhet, are the same.

The tree which furnishes this precious incense is chiefly found in that part of Asia called the Peninsula beyond the Ganges. The mountainous countries to the east and south-east of Silhet, where our tree grows, are fairly within this division, and correspond pretty well with the range given by Loureiro to his *Aloexylum verum* or *Agallochum*, which is some small additional proof of their being the same; and, indeed, through the whole of the above notices, taken from such authors as are within my reach, there runs such an uncommon share of coincidence, as to induce me to believe they all relate to the same identical object. By this belief I must acknowledge my account of my *Amyris Agallocha*, so far as it relates to its yielding *Calambac*, to be erroneous. It is needless to detail the source of the error; suffice it to say that I acknowledge it, and also acknowledge myself to have been much to blame for believing those who gave me the information, which has unfortunately been published, or publishing, in the third volume of my 'Indian Plants.'

EXPLANATION OF THE PLATE.

Tab. XXI.

Fig. 1. A small branch of *Aquilaria Agallochum*, in flower:—nat. size.

Fig. 2. One of the flowers laid open, exposing to view the pistillum, part of the nectaries, and stamina (part being removed):—magnified.

Fig. 3. One of the nectaries between two of the stamina:—magnified.

Fig. 4. Transverse and vertical sections of the germ:—much magnified.

Fig. 5. The capsule.

Fig. 6. The same, opened, exposing one fertile cell, with its seed, and one abortive cell.

Fig. 7. The entire seed and umbilical cord.

Fig. 8. The same, with half of the two exterior integuments removed. These four are of the natural size.

Fig. 9. The seed removed from the two exterior integuments.

Fig. 10. Transverse section of the same.

Fig. 11. A vertical section.

Fig. 12. The plumula and radicle:—much magnified.

Fig. 13. The two cotyledons.

Remarks by Henry Thomas Colebrooke, *Esq., F.R.S., F.L.S. &c.*

The information received from Mr. Dick, concerning the manner of collecting the Aloe-wood, corresponds so nearly with other notices on the same subject, as to afford a strong confirmation of their general accuracy.

The following account is by the author of the 'Mekhzen úl adveyeh,' whose near relation to the Nawab Mahammed Reza Khan afforded him opportunities of inquiry, of which he diligently availed himself.

"*Uúd* signifies wood or branch, and emphatically, the wood called *Uúd Hindi*, or, in the Hindi language, *Agar*. It is obtained from a species of tree found in the mountainous country of Jentiya, near Silhet, in the north-east of Bengal*.

"The tree is very lofty, its trunk and branches are generally crooked and rather soft, so that neither clubs and walking staves, nor bowls and platters, can well be made from them, by reason of their softness and crookedness. Besides, the tree is in many parts hollow.

"Until the wood be old and have remained long after being cut down, so that it may decay and rot, it does not acquire its proper fragrance. To accelerate this change, the wood is buried in moist ground, and being afterwards dug up, so much of it as is dark-coloured and of a glossy unctuous appearance, and found upon trial to sink in water, is selected and set apart under the denomination of *gharkí*. Any remaining portions of unmellowed wood are carefully separated from it by means of an iron instrument to obtain the *gharkí* in a pure state. Specimens which sink but partially are termed *nim-gharkí*, or semi-mergent. Those which float are called *semleh*, or dregs, and are the most common but least esteemed.

"This fragrant wood is of various sorts, distinguished by the names of *Hindí*, *Samadúrí*†, *Kumárí*, and *Mandalí*. The *Hindí* is of the darkest colour; the *Samadúrí* has a more unctuous appearance than the Indian sort. The *Kumarí* is of a lighter colour. The *Hindí* (should be *Mandalí*) is the most fragrant of all.

"It is likewise distinguished as *Bari* and *Jabalí* (rustic and mountainous), the latter with black streaks, the former with white; some, however, reverse these characters.

"The *Samadúrí* is named from the country whence it is brought; so is the *Kumárí*‡.

"In medicine, the *Hindí* from Silhet in Bengal, of the quality called *gharkí*, being bitter, fragrant, unctuous, and a little hard, is preferred§, because the Aloe-wood of other places does not equal it in fragrancy and excellence.

"In some recipes and prescriptions, it is directed that crude *úúd* should be taken‖.

* The 'Tohfet úl muminín' says, it is a tree which grows in the islands of China and India.

† The 'Tohfet úl muminín' writes this *Samandúrí*.

‡ The varieties of this wood are denominated from the countries which produce them, as *Samandúrí*, *Hindí*, &c.—*Tohfet úl muminín.*

§ The best kind is black, hard, shining, fragrant and bitter, sinking in water. This is the *Hindí*, and the *Kumárí* is of a lighter colour. The *Samandúrí* is more unctuous. The rustic and mountainous varieties of it have white stripes. That which swims in water is bad.—*Tohfet úl muminín.*

‖ This direction is to be found also in the recipes of the Greek and Arabian physicians, compiled by Nicolaus Myrepsicus. See Rumphius, ii. 39.

This is intended for a caution against employing that from which the essential oil has been already extracted, for fraudulent dealers sell the refuse of the wood after the oil has been drawn from it. The process of extraction consists in macerating in water and then distilling. The produce of distillation, on cooling, yields the essential oil. Some put a few almonds with the residuum and extract the oil by inversion. This is termed *Chúwah-agar*. It is not so fragrant as the genuine *Chúwah*, obtained without the addition of almonds, from the raspings of Aloe-wood which have not been distilled. Some again mix raspings of Sandal-wood, and proceed to distil, and then collect the essential oil from the produce of the distillation when cold. This likewise is less fragrant than the purer kind.

"The author of the 'Akhtiyárát-bádúí' has said, that it comes from Bandar Chineh, situated at a distance of ten days from Java; and this is exceedingly scarce, so that it is sold for its weight in gold. It appears to have no smell, but when it is held in the hand and becomes warm, it sweats and diffuses a most exquisite fragrance, which is very permanent. This is true, and agrees with what the author has also learnt from oral information. The name may be merely an error of the transcriber.

"Another sort of wood, very similar in its appearance to the *Uúd*, is found in Bengal, and is sold for it to the unwary. It is named *Tagar**."

The close of this passage may excite a doubt whether the tree mentioned by Mr. Dick's informant, under the name of *Tagar*, be really the same with that from which the *Agar*, or Aloe-wood, is obtained. However, it is not unlikely, notwithstanding the general accuracy of the author of the 'Mekhzen úl adveyeh,' that his distinction between the *Tagar* and the *Uúd* is unfounded.

The four varieties of *Uúd* noticed by this author correspond nearly to the four sorts which the Arabian writers have described under similar denominations, taken, as observed by them also, from names of places. In the Latin translation of Serapio†, the denominations are—1. *Indum*, the best sort, black and ponderous, found in a certain island of India called Finma. 2. *Mondanum*, so called from the Indian city Mondel. 3. *Seificum*, from Seifi, situated at the distance of three days from the place which gives name to the next sort. 4. *Alcumericum*, the kind least valued. In three out of four instances, the correspondence of names is conspicuous and exact.

Sanscrit writers have three varieties of the Aloe-wood: 1st, *Aguru*, the common sort; 2nd, *Cáláguru*, or black aloes, being of a darker colour than the common kind; 3rd, *Mangalyá*, or *Mangalyaguru*, having the fragrancy of the *Mallica*, or *Jasminum Zambac*.

I know not whether it would be too strained an etymology to derive *Mandalí* (*Mondanum* of Serapio) from the Sanscrit *Mangalyá*. But there can be no hesitation in deducing the Malay name of the Aloe-wood, *Garo*‡, as well as the denomination which it bears in every provincial language of India, *Agar*, from the Sanscrit *Aguru*. Yet the regular etymology of this term (from *a* privative, and *guru* heavy) does not convey a very

* If this is the produce of a different tree, it may be that of Dr. Roxburgh's *Amyris Agallocha*, a native of the same country, and said to yield Aloe-wood.—*R.* [But see p. 203.]

† *c.* 197, as quoted by Garcias, Hist. Aromat. 65, and Rumphius, Herb. Amb. ii. 39.

‡ Rumphius (Herb. Amb. ii. 39) supposes this to be the original of Pliny's *Tarum*; but Salmasius denies that the *Tarum* of Pliny is the *Agallochum*.

suitable appellation for a ligneous substance, in which a discriminative sign of its excellence is its specific gravity exceeding that of water. Grammarians have therefore given a different turn to the etymology of the word, as indicating a substance than which nothing is weightier, that is, more valuable*. I observe, nevertheless, among the Sanscrit synonyma for Aloe-wood, *Laghú*, properly signifying light. It is difficult to assign a satisfactory reason for this name.

Other Sanscrit denominations which merit notice are, *Crimija*, signifying produced by insects, and *Gandha-cashtha*, fragrant wood. The first implies a notion, which is not an improbable one, that the conversion of the wood into an aromatic substance is occasioned by wounds of insects. The other corresponds in its import with the Arabic name *Uúd*, a term answering in sense, as in sound, to the English word *wood*, and applied emphatically by the Arabian physicians to the aromatic wood in question.

Avicenna† has treated, under separate heads, of *Uúd* (which his translator writes *Haud*) and *Aghálují*, written in the Latin version *Agalugen*. But later authorities among the Arabian and Persian physicians concur in affirming that *Aghálují* is the same with *Uúd*, being its Greek denomination‡. They clearly intend the *Agallochon* of Dioscorides§.

It is not, therefore, right to derive *Agallochum* from the Arabic, since this, on the contrary, is confessedly borrowed from the Greek. Neither is its origin to be sought in the Hebrew *Ahalim* and *Ahaloth*, as proposed by Salmasius||, since it is more obvious to deduce it from the language of the country whence the drug was brought, and the Indian name *Aguru*, or with the Sanscrit pleonastic termination *ca*, *Aguruca*, is much nearer to the sound of the Grecian term.

It may be remarked by the way, that the Portuguese *Pao de Aquila*, as noticed by Rumphius, is an undoubted corruption either of the Arabic *Aghálují* or of the Latin *Agallochum*, and it is, by a ludicrous mistake, that from this corruption has grown the name of *Lignum Aquilæ*, whence the genus of this plant now receives a botanic appellation, and which many authors¶ have vainly attempted to distinguish from the *Lignum Aloes* and *Calambac***.

The generic and specific names of the plant then are both drawn from the same original term, a circumstance, however, not unprecedented in the Linnean nomenclature.

* Commentators on the *Amera-cósha*.

† Quoted by Garcias, Hist. Aromat. p. 65, and Salmasius, Plinianæ Exercitationes, p. 1055.

‡ 'Tohfet úl muminín' and 'Mekhzen úl adveyeh.'

§ Dioscorides, lib. i. cap. 21.

|| Plinianæ Exercitationes, p. 1054. From the same Hebrew word Salmasius deduces *Aloe*. Isidorus derives it from *allar*, a silly etymology, as Salmasius remarks.

¶ Bauhin, Pomet, Lemery, &c.

** A Malay name of the Aloe-wood, derived, according to the conjecture of Rumphius, from the Chinese *Kilam*.

XXII. *On* Acradenia, *a new Genus of* Diosmeæ. *By* Richard Kippist, *Esq., Libr. L.S.*

Read June 1, 1852.

The plant to which I propose to call the attention of the Society this evening, is one of a highly interesting collection, formed in the neighbourhood of Macquarie Harbour, by the indefatigable Secretary of the Royal Society of Van Diemen's Land, Mr. Joseph Milligan, by whom, through the instrumentality of our lamented member, Mr. Bicheno, they were kindly presented to the Society.

It belongs to the Diosmeous section of *Rutaceæ* (Tribe *Boronieæ*), and *in habit* most nearly approaches *Zieria*, to the larger-leaved species of which it bears, at first sight, considerable resemblance. From this genus, however, as well as from *Melicope*, *Boronia*, and *Cyanothamnus*, it is readily distinguished by the quinary division of the parts of the flower, and by its more numerous stamens. From *Eriostemon*, *Crowea*, and *Philotheca*, with which it agrees in the number of its floral organs, it differs in having perfectly glabrous filaments, and smooth inappendiculate anthers; and from the latter genus, in addition, by the filaments being distinct, not, as in *Philotheca*, united below into a tube.

Another genus of Australian *Diosmeæ* with which it accords very nearly in many of its artificial characters, is *Geleznovia*, a remarkable plant with the general aspect of *Eriostemon*, recently described by Turczaninow, from Drummond's Swan River Collections, in the Bulletin of the Imperial Society of Naturalists at Moscow. The points of agreement are, the quinary division of the calyx and corolla, the smooth subulate stamens (ten in number), and glabrous inappendiculate anthers; but the calyx in *Geleznovia* is coloured, and as long, or rather longer, than the corolla, the anthers are strictly terminal, and the entire surface of the carpels is covered with elevated tubercles, each surmounted by a tuft of radiating hairs.

From all the above-mentioned genera the Tasmanian plant is distinguished by the structure of its ovaries, which adhere closely together, and are everywhere clothed with a dense tomentose covering; except that each bears, at its upper external angle, a naked sessile tubercle or gland, large enough to be readily observed with the naked eye; a character which I have been unable to discover in any closely allied genus, and it has consequently suggested the name *Acradenia*, by which I would propose to designate my plant.

I am unable to speak positively as to the precise nature of these glandular bodies, or to say whether any exudation proceeds from them: when examined under the microscope, they appear to be perforated by a tube, widening below, and communicating with the internal cavity of the carpel. From the exact correspondence in their position, however, they are probably analogous to the cornute appendages which crown the ovaries of

some species of *Phebalium*, but in that genus they are occasionally developed into subulate or nearly cylindrical horns, almost as long as the carpels themselves.

In the structure of its mature capsule, *Acradenia* appears to differ from most, if not the whole, of its more immediate allies, the endocarp remaining, when ripe, firmly united to the epicarp, instead of separating from it in two elastic valves, as is usually the case in other *Diosmeæ*.

We have, unfortunately, no information from its discoverer with respect to the dimensions which the plant attains, but the dried specimens have all the appearance of having been broken off from a shrub of considerable size. They are much branched, and copiously furnished with opposite ternate leaves; these are remarkable for their coriaceous texture, and the extreme roughness and harshness of their upper surface, which is dark green, and covered with prominent glandular tubercles, while the under side is perfectly even, and (in the *dried* specimens) of a ferruginous brown.

From its close resemblance in habit to *Zieria*, I had originally intended to employ the specific name "*zierioides*"; but Mr. Brown having kindly communicated to me a specimen, gathered by Mr. Milligan on the banks of the Franklin River in April 1842, on a ticket attached to which Mr. Milligan proposes to name the plant "*Zieria Frankliniæ*," after Lady Franklin (who, with her husband, Sir John, were, I believe, his companions on that journey), I have much pleasure in altering the specific name to *Frankliniæ*, in accordance with the wishes of its discoverer. On the same ticket Mr. Milligan speaks of the plant as handsome and fragrant; but as he at that time saw no flowers, the latter term can only be intended to apply to the leaves, which, as in the majority of the *Diosmeæ*, are copiously furnished with pellucid dots, reservoirs of essential oil, and exhaling probably the peculiar odour which characterizes that family.

ACRADENIA.

CHAR. ESSENT. *Calyx* 5-partitus. *Petala* 5, hypogyna, calyce multo longiora, æstivatione imbricata, ovato-elliptica, undique velutina. *Stamina* 10, hypogyna, petalis sublongiora, alterna paulò breviora; *filamenta* libera, subulata, glabra; *antheræ* introrsæ glabræ, biloculares, rimâ longitudinali dehiscentes, apice inappendiculatæ. *Ovaria* 5, gynophoro disciformi margine sinuato insidentia, 1-locularia, villosissima; singulo apice glandulâ majusculâ sessili instructo. *Ovula* in loculis gemina, suturæ ventrali collateraliter inserta, pendula. *Styli* in unicum glabrum coaliti. *Stigma* subcapitellatum. *Capsula* 5- (vel abortu 1–3-) cocca; cocci subquadrati, compressiusculi, glabrati, apice truncati et extùs brevè cornuti, coriacei, transversim rugosi; *endocarpio* haud secedente. *Semina* ......?

Frutex *tasmanicus, ramosissimus*; foliis *oppositis exstipulatis, petiolatis, 3-foliatis*; foliolis *coriaceis, lanceolatis, serratis, suprà tuberculatis*; pedunculis *terminalibus, trichotomè cymosis, multifloris*; floribus *albis*.

ACRADENIA FRANKLINIÆ. *Zieria Frankliniæ*, Milligan, MSS.

Frutex ramosissimus, floribus ramulisque junioribus exceptis, glaberrimus. *Rami* teretes, oppositi vel subverticillati, cortice lævi vel subrugoso tecti. *Folia* opposita, exstipulata, brevè petiolata, trifoliata. *Petioli* vix semipollicares, suprà canaliculati, subtèr convexi. *Foliola* 2-uncialia, coriacea, discolora, lanceolata vel obovato-lanceolata, margine revoluta, versus apicem obtusum serrulata, basi attenuata integerrima; suprà glanduloso-tuberculata atro-viridia, subtèr pallidiora lævissima vel glandulis minùs prominentibus parcè conspersa, undique nitida; nervo medio valido utrinque prominente, venulis

immersis inconspicuis. *Cymæ* terminales, trichotomæ, multifloræ, pedunculo communi teretiusculo vel compresso subpollicari, ramisque oppositis teretiusculis, pilis brevibus patulis velutinis nigrescentes. *Bracteæ* subulatæ, pilis longioribus lutescentibus appressis densè tectæ. *Pedicelli* divaricati ebracteolati (5–6 lin. longi). *Calyx* profundè 5-partitus, sepalis ovatis, carnosulis, extùs margineque hirsutis, intùs glabris. *Petala* 5 (vel quandoque 4), calyce 5-plò longiora, æstivatione imbricata, sub anthesi patentia, ovato-elliptica, brevissimè unguiculata, basi sub 5-nervia, alba, undique pilis simplicibus crispatis velutina. *Stamina* 8–10, hypogyna (persistentia?), petala subsuperantia, alterna iisdem opposita paulò breviora; *filamenta* omninò libera, lineari-subulata, lævia (sub antherâ haud dilatata), glaberrima: *antheræ* introrsæ, ovato-cordatæ, glabræ, biloculares, rimâ longitudinali dehiscentes, apice inappendiculatæ. *Ovaria* 5, in germen pentagonum cohærentia, gynophoro disciformi glabro margine sinuato insidentia, unilocularia, villosissima, singula apice ad angulum externum glandulâ tuberculove majusculo sessili instructa. *Ovula* in quoque loculo gemina, suturæ ventrali collateraliter inserta, pendula. *Styli* ex ovariorum apice in unicum, glabrum, angulatum, subulato-linearem, stamina subæquantem, germine subduplò longiorem, coaliti. *Stigma* subcapitellatum, vix lobatum. *Capsula* sub-pentacocca; cocci (quorum 1–3 sæpè abortivi) basi subcohærentes, sepalis persistentibus pluriès longiores, subquadrati v. rhomboidei, paulò compressi, basi rotundati, apice abruptè truncati et angulo externo brevè cornuti, coriacei vel sublignosi, dorso carinati, transversim rugosi, extùs glabriusculi, intùs sulcati glabri; *endocarpio* haud secedente. *Semina*......?

Hab. ad margines sylvæ densæ prope Portum Macquarie dictum, Insulæ Van Diemen; ubi floribus expansis legit Dom. Jos. Milligan mense Decembris 1846, et iterum Martii 1847.

I take this opportunity of expressing my obligations to Sir William Hooker for having kindly afforded me the opportunity of examining the flowers in a living state; thus enabling me to supply some particulars with regard to colour, &c., on which little or no satisfactory information could be obtained from the dried specimens. I regret to find, however, that the plant is not likely at present to ripen its fruit at Kew. Mr. Smith informs me it was first introduced to the Botanic Garden in 1845, in a case sent by Dr. M'William from Norfolk Island, where, however, it is scarcely possible that it should be indigenous.

EXPLANATION OF THE PLATE.

Tab. XXII.

Fig. 1. A branch of *Acradenia Frankliniæ*, of the natural size.
Fig. 2. Flower, with four of the stamens removed:—natural size.
Fig. 3. Sepal:—magnified.
Fig. 4. Petal:—magnified.
Fig. 5. Stamen:—magnified.
Fig. 6. Ovarium, seated on its gynophore:—magnified.
Fig. 7. Transverse section of ovarium:—magnified.
Fig. 8. Longitudinal section of one of the carpels:—magnified.
Fig. 9. Ripe capsule:—natural size.

R. Kippist del.

G. Jorman sc.

XXIII. *On the Genus* Myrmica, *and other indigenous Ants.*

By JOHN CURTIS, *Esq., F.L.S. &c.*

Read March 21, 1854.

NOTWITHSTANDING the valuable volume published by Latreille in 1802 * upon the Ants, the species inhabiting our island were but imperfectly known until very recently. That talented naturalist divided the *Formicidæ* into several families or sections, which he subsequently named; and he found simple and admirable characters for dividing the European forms into two groups.

It is one of the characteristics of the *Hymenoptera*, that the abdomen is attached to the trunk by a neck or petiole, more or less attenuated †. Every one is familiar with the structure of the Wasp, which is a good example of the petiolated *Hymenoptera*. In the Ants, however, this connecting portion or petiole is very peculiar in its form, being furnished on the upper surface with scales or nodules ‡. This forms the basis of Latreille's subdivision of the Ants, one section having a single scale, the other two nodules on the petiole.

It is true that the valuable monographs of Nylander § and Foerster ‖ have lately cleared the way and placed us in a better position, but owing to the fact that each species of Ant exhibits three phases, the study of the family becomes complicated, and unless one can detect and examine a nest, when the Ants begin to swarm, it is not easy to decide with certainty upon the relationship of individuals; consequently there are many species whose history is not complete, and many points remain unsettled. The workers, or neuters as they are called, of most species are abundant enough, and the females of some families resemble them, but the males are generally very different, whilst the females are often deprived of their wings; and even amongst the workers there are two kinds varying in size if not in other respects; so that to an unpractised eye a nest might appear to be inhabited by five different kinds of Ant.

With such a complication of materials it is not surprising that errors in our nomenclature should exist, and I present this Essay to the Linnean Society more with the hope of inducing young and zealous entomologists to study this interesting family, than with any great expectation of producing much myself that is new, or of rendering the nomenclature perfect.

* Histoire naturelle des Fourmis.

† In some instances this neck is so short that the connecting portion is invisible, and the Saw-flies (*Tenthredinidæ*) are altogether an exception, the abdomen being sessile; but it is remarkable that the larvæ in that family resemble caterpillars, and have not only feet, but a greater number than any other larvæ of insects, amounting in some species to twenty-two, whilst in *Lepidoptera* the maximum is sixteen feet.

‡ *Vide* the plates to Mr. Smith's Monograph of the Genus *Cryptocerus* in the Trans. Ent. Soc. N. S. vol. ii. p. 213.

§ Adnotationes in Monogr. Formic. Borealium Europæ, 1846.

‖ Hymenopt. Studien, 1tes Heft, 1850.

On comparing the species of *Myrmica* in my cabinet with the Collection in the British Museum, which has been arranged by Mr. Smith, who has paid particular attention to the Ants, I was enabled to make some notes, and I hope clear up some doubts by the investigation, having had thereby the advantage of examining the typical specimens presented by M. Nylander to our national museum.

I therefore propose to describe and figure some English *Myrmicæ*, which are either new, or so little known, that it appears to me impossible to identify the species. I trust that the figures will at all events render a few species no longer doubtful; and as no dissections, that I am aware of, have been given of *Myrmica*, nor any very elaborate characters exhibited, I shall endeavour to supply the deficiencies.

The British *Formicidæ* may be thus divided:—

A. with a single scale upon the petiole.
  Palpi 6- and 4-jointed.
    Mandibles of female elongated.. 1. *Formica*, Linn.
    Mandibles of female triangular .... 2. *Ponera*, Latr.
B. with two nodules on the petiole.
  Superior wings with the apical cell elongate and open.
    Palpi 6- and 4-jointed .... 3. *Myrmica*, Latr.
    Palpi 4- and 3-jointed* .... 4. *Stenamma*, Westw.
  Superior wings with the terminal cell closed, oval and pedicled... 5. *Myrmecina*, Curt.

Myrmica, Latreille.

Male. Head smaller than the thorax, rhomboidal (fig. 11): eyes globose and prominent: ocelli very distinct, in triangle behind the eyes. Antennæ inserted in cavities in front of the face, approximating, not long, geniculated, slightly clavate, hairy and 13-jointed; basal joint generally one-third of the entire length†, second obconic, the six following more or less ovate, the remainder forming a slightly enlarged club of obovate joints, the last being the longest, stoutest and conical (fig. 1). The trophi are small: Mandibles meeting in front, hairy, narrowed towards the base, dilated anteriorly and truncated obliquely, the margin forming but few teeth (2). Maxillæ producing longish drooping Palpi, pilose and 6-jointed, three basal joints the stoutest, fifth the shortest, sixth the longest, elliptic-conic (3). Mentum obtrigonate, with a small semicircular labium: Palpi remote, not long, but slender and 4-jointed, second joint the longest (4). Thorax attached to the head by a distinct neck, elongate-ovate, scutel semicircular, postscutel produced into a short spine at each angle. Petiole stoutish, composed of two knots, the basal one somewhat pear-shaped, second broader and globose: abdomen larger than the thorax, ovate-conic, the basal segment covering more than half the surface. Wings ample, especially the superior, which exhibit a longish stigma with two discoidal cells, the upper one large and partially divided by a short nervure; the posterior cells incomplete (fig. 13). Legs not long but slender; anterior tibiæ furnished with a longish spine at the apex, slenderer in the others: tarsi 5-jointed, basal joint of first pair very rigid and arched at the base, much longer in the hinder pair; terminal joint dilated at the apex, with distinct pulvilli and sharp claws.

* This character I take on the authority of Mr. Westwood, not having dissected *Stenamma*.

† In *M. rubra*, from which species all these generic characters are taken, the scape is scarcely longer than the terminal joint in the male.

Female stouter. Head much larger: eyes small: ocelli very minute. Antennæ less elongated than in the male, and 12-jointed; basal joint always elongated, second longer than the six following, and the club more robust (5). Mandibles large and prominent, concavo-convex, forming serrated spoons, the teeth more numerous than in the males (6). Palpi similar to those of the neuter. Thorax rather short, broad in front and obtuse, postscutel producing two longish slender spines. Petiole and abdomen similar to the male, but furnished with a concealed sting. Wings as in the male. Legs stouter, the thighs and tibiæ being incrassated; tarsi similar, but shorter and stouter.

Neuter resembles the female, but is much smaller; the Antennæ are longer in proportion, and 12-jointed (7). Ocelli none. The trophi are very minute, excepting the Mandibles, which are comparatively large, crossing, very dilated at the extremity, truncated obliquely and producing 5 or 6 teeth (8). Labrum undiscovered. Maxillæ terminated by an oblique subovate very hairy lobe, and furnished with a slender drooping Palpus of 6 joints (9). Mentum chalice-shaped or obconic, with two remote Palpi of 4 joints (10). Thorax much narrower than the head, contracted at the middle; postscutel with 2 slender spines. Wings none. Sting concealed.

1. M. RUBRA, Linn. Faun. Suec. 1725; De Geer, vol. ii. p. 1093. pl. 43. figs. 1–14. *M. scabrinodis*, Nyl. var.

This is a most abundant insect, forming colonies, in meadows, on heaths and banks. The different species of *Myrmicæ* live principally under stones and clods, but they secrete themselves beneath the bark of trees and in moss. It should be observed that the pupæ are not enclosed in cocoons, in which they differ from the true *Formicæ*. The males fly in the evening, and the females are frequently found deprived of their wings, after pairing.

2. M. LÆVINODIS, Nyl. Mon. 927. 1.

Taken in the middle of July at Folkestone by Mr. J. S. Baly, and towards the end of August I captured the male in Caen-wood.

3. M. VAGANS, Fabr. Ent. Syst. ii. 358. 37. *M. ruginodis*, Nyl. Mon. 929. 2.

As this is undoubtedly the Fabrician species, I have restored the original name. It has been taken in the middle of July, at Sandown, in the Isle of Wight, by Mr. F. Smith.

4. M. LONGISCAPUS, Curt.

This species resembles *M. lævinodis*, but the males are much smaller, the antennæ are much longer, and instead of the scape being only as long as the two basal joints of the flagellum, as in *M. lævinodis* and *M. rubra* (fig. 1), it is equal in length to the eight following joints (fig. 12). The head is less convex, there is no channel down the forehead, and the clypeus is testaceous (fig. 11). There is a fovea on the hinder margin of the second nodule; the wings do not differ (fig. 13). The females, of which I have no winged specimen, are very similar to those of *M. lævinodis*, but they are darker, and the basal nodule is shorter and stouter (fig. 14). The neuters are smaller and different in colour from those of *M. lævinodis*, being entirely ochreous, excepting the black eyes and a brownish cloud on the back of the abdomen.—Male $2\frac{1}{3}$ lines; female 3 lines; neuter $1\frac{3}{4}$ to 2 lines long.

I am aware that the length of the scape is supposed to vary in the males, but

as the species under consideration was taken in abundance, from the same nest in Scotland in 1825, all having long scapes, it seems to me to be distinct from *M. rubra* or the allied species: moreover, if this extraordinary disparity of the scape were merely a variation, how is it that the same difference is not observable in the other species?

I possess four males, two females and four neuters, found in July in Perthshire, and I have received males and females taken out of one nest in the neighbourhood of Manchester by Mr. R. Wood.

5. M. PERELEGANS, Curt.

The *male* (fig. 15) is pitchy, shining: head finely striated, with a faint channel down the face: mandibles ochreous: antennæ longish, slender and ochreous; scape scarcely one-third the entire length, pitchy, except at the extremities: fore part of thorax smooth, with a few comma-shaped impressions and two longitudinal channels in front, hinder portion striated; scutel roughish punctate-striate; postscutel regularly and distinctly striated, abrupt and concave behind, the angles not produced. Petiole stoutish, first nodule punctured, second very smooth and shining, as well as the abdomen, which is tawny, and a little pubescent towards the extremity. Stigma and nervures nearly colourless. Legs ochreous; thighs and tibiæ pitchy, excepting at the extremities: length $2\frac{3}{4}$ lines.

Female (fig. 16) clear ochreous-red: upper side of head, excepting the margin, black, more rugose-striate than in the male; the clypeus striated, with a band of very fine striæ between the antennæ, which are fulvous; mandibles bright ochreous, the teeth pitchy. Thorax similarly sculptured to the male, but the scutel is striated, and the angles of the postscutel form two long, slender, incurved spines: first nodule with a circular cavity on the back, leaving an elevation in the centre; second pilose: abdomen entirely glossy black, with scattered pale hairs. Legs fulvous, the middle of hinder thighs and tibiæ brown. Stigma and nervures visible, pale fulvous: length 3 lines.

The *neuter* (fig. 17) resembles the female in form, and is exactly similar in the disposition of the colours, only that the thorax and petiole are of a deeper brick-red, with the legs reddish, and all the thighs and legs are darker. The thorax is contracted in the middle and striate-punctate, forming ridges in front: the pit on the first nodule forms a circular margin with an island in the centre: length $2\frac{1}{3}$ lines.

This species seems to approach the *Formica subterranea* of Latreille, but the neuter has the upper surface of the head black, and the first nodule has not a long petiole, as described and represented in all Latreille's figures. The male has not very pale yellow legs; nor the female a brown, very shining thorax, with a brown petiole. It may be related to Fabricius's *F. acervorum*, but he describes that species as having the back of the thorax black.

This new and elegant species I found in July 1850, under a stone, on a heath near Bournemouth in Hampshire. The males were scarce, the females more abundant; the workers were in considerable numbers, and on being disturbed they ran away with the pupæ, hiding themselves in holes and amongst the grass.

6. M. ACERVORUM, Fabr. Ent. Syst. vol. ii. p. 358. *M. lacteipennis*, Zett. Ins. Lap. ♂.

I have never met with this species, but Mr. Smith has taken the male, flying in abundance in a fir-grove in Hants, in September, and also under bark of trees in the same county.

7. M. DENTICORNIS, Curt.

Male (fig. 18) pale dull castaneous, sparingly hairy: head with indistinct irregular striæ; eyes black; mandibles pale straw colour. Antennæ fulvous. Thorax smooth, shining, indistinctly sculptured; the scutel with an ochreous margin, finely striated, as well as the postscutel, which is concave behind, the angles forming short acute spreading spines. Petiole with ochreous articulations; basal nodule a little elongated and irregularly striated, second nodule smooth and shining: abdomen very glossy, often darker, the margins of the segments paler. Wings slightly tinted, the stigma and nervures pale fulvous. Legs fulvous; coxæ, tips of thighs and tarsi pale ochreous: 2½ lines long.

Female undiscovered.

Neuter (fig. 19) castaneous-black: head finely striated, clypeus with fewer but stronger striæ; mandibles ochreous, the teeth and base pitchy. Antennæ fulvous, stoutish, considerably clavate (fig. 20), the scape angulated at the base and producing a minute dark tooth (fig. 20*f*). Thorax very rugose, being irregularly sculptured all over, the angles of the postscutel forming two long divaricating spines, pale at the tips. Petiole stoutish, basal nodule ovate, truncated behind, second globose, both very rugose: abdomen very smooth and shining, with short pale scattered hairs, and subferruginous at the apex. Legs entirely fulvous; thighs and tibiæ clavate: length 2 lines.

By the peculiar contour of the scape at the base, which forms a knee producing a minute tooth in the neuter, and probably is similar in the female, this very distinct species is no doubt allied to the *M. lobicornis* of Nylander; but as this tooth is much less developed than in his *Myrmica* *, and he says, "*capite*, thorace nodisque segmenti primi longitudinaliter *striatim profundè rugosis* †," our insects must be different, for the head of mine is merely finely striated, and the thorax and *both* nodules are exceedingly rugose, but not longitudinally striated.

I secured three males and four neuters from a nest in Scotland in July 1825; but I did not observe any females.

8. M. CÆSPITUM, Linn. Faun. Suec. 1726; De Geer, vol. ii. p. 1105. pl. 43. figs. 15 & 16 ☿, figs. 21 & 22 ♂. *M. fuscula*, Nylander, p. 935, & pl. 18. fig. 34 ♀, & p. 1053 ♀. *M. impura*, Foerst. var. teste D. Nylander, and possibly *M. modesta*, Foerst., also.

I only know the male of *M. cæspitum* by De Geer's memoir and figures, and until we possess that sex, together with undoubted females, I shall not be satisfied regarding our members of this species, for our neuters do not altogether accord with Nylander's and Foerster's descriptions. In the British examples, the tibiæ, as well as the thighs, are pitchy, the head is finely striated, not rugulose, neither will the sculpture of the thorax

* Adn. Mon. Form. pl. 18. f. 32. † *Ibid.* p. 932. 4.

bear that construction, excepting the postscutel: the profile of the petiole and the spines given in Nylander's plate * agree, however, very well with our insect.

It is strange that the males of this species should not have been detected in England, as the neuters are not uncommon, and the females, if such they be?, have also been found. These females are so distinct from any other species, that I had given them the name of *maculipes*. The form of the head, thorax and nodules is very peculiar.

In the middle of April 1829 I collected some of the neuters at Southend: I found them at the roots of plants at the base of the cliff, and subsequently in June I met with a small variety at Darent in Kent. Mr. Smith has found them not uncommon at Sandown Bay in the Isle of Wight, and also at Folkestone. The two females alluded to, agreeing with M. Nylander's *M. fuscula*, were discovered by Mr. Dale, under a stone at Charmouth in July, and they had lost their wings.

9. M. TUBERUM, Fabr. Ent. Syst. ii. 358. 36; Latr. Hist. Fourm. p. 74 ♀. *F. tuberosa*, Latr. p. 259 ♀.

This species requires investigation. I have a pale neuter, which agrees with one of Nylander's specimens; I believe it came from Dorsetshire: Mr. Smith has taken others on Shirley Common, Surrey; and Mr. Wing met with several under the bark of an oak-tree at Brixton the beginning of April. They were all neuters.

10. M. SIMILLIMA, Nyl. MSS.; Smith's List Brit. Mus. part 6. p. 118.

The neuters of this insect were taken I believe by Mr. Dale in Dorsetshire.

11. M. GRAMINICOLA, Latr. Hist. Fourm. p. 255.

On the 20th of May I took a neuter on a bank at Dinton near Wilton, and I believe it is abundant under stones on the Downs there. Mr. Smith finds it under stones at Weybridge, Surrey.

Latreille's descriptions are too vague to enable me, without seeing his examples, to decide regarding this species. When I published the Genus *Myrmecina* in 1829, I thought it possible my species might be the one indicated in the 'Histoire naturelle des Fourmis,' as the wings of the male *F. graminicola* are described as entirely blackish, and at that time I only possessed that sex; but Latreille compares his insect to the *F. rubra*, and makes no mention of the difference in the neuration of the wings, which would scarcely have escaped so acute an observer, especially as he remarks that the nervures are black; and as our *females* agree in no respect with Latreille's description, I cannot think that our insects are identical. M. Foerster seems to be unacquainted with the neuters and females of *M. graminicola*, and the male which he describes is undoubtedly my *Myrmecina Latreillii*.

12. M. UNIFASCIATA, Latr. Hist. Fourm. p. 257.

This pretty species is recorded by Mr. Smith as inhabiting moss in Coomb-wood, Surrey. The only specimens I possess are apterous females and neuters. I found them under the

* Adn. Mon. Form. pl. 18. f. 34.

bark of felled trees and in moss at the base of poplars near Pau, Basses Pyrénées, in January 1853. I am unacquainted with the male, unless it be a *Stenamma.*

13. M. DOMESTICA, Shuck.; Smith's List of Brit. Mus. p. 119 *.

This, the smallest of the Ants, is the greatest of all pests, when it establishes itself in a house, as from its minuteness and activity it insinuates itself into every crevice. My attention was called to this mischievous creature many years since. It was first discovered in London in a bakehouse, and my impression at the time was, that it had been introduced with foreign maize into this country, which is supported by the fact that it cannot endure cold †.

There is no difficulty in obtaining the workers, but the males and females are less abundant, and not always to be found. My specimens of these are not sufficiently perfect to ascertain if the neuration of the wings differs materially from the typical species, but from Mr. Westwood's figures I am disposed to think that *M. domestica* is a species connecting the *Myrmicæ* and *Stenamma.*

STENAMMA, Westwood.

14. S. WESTWOODII, Steph.; Westw. Intr. Class. Ins. vol. i. p. 83, & vol. ii. p. 226. fig. 86. 11.

Male slender, pitchy-black, shining; head somewhat ovate, not smooth, eyes prominent: three distinct ocelli on the crown: mouth ochreous, mandibles large: antennæ tawny, approximating, very slender and 13-jointed; scape one-fourth the entire length, second and following joints somewhat elongated, the five last being thickened, the apical joint the longest and conical. Thorax rather broader than the head and indistinctly striated; scutel semicircular and rugose; postscutel with the angles acute. Petiole elongated, basal joint long, slender and pear-shaped, second broader and subglobose: abdomen ovate-conic, edges of the segments and apex ochreous. Wings slightly tinted, stigma and nervures very pale tawny; submarginal cell very long, discoidal, rather small and rhomboidal, apical cell elongate and open (fig. 21) ‡. Legs long and very slender, especially the hinder pair, ochreous; thighs and tibiæ pitchy, except at their extremities: length $1\frac{2}{3}$, expanse $4\frac{1}{4}$ lines.

The males only of this insect are known. I first took one at Black Gang Chine, in the Isle of Wight, in the middle of October 1829. As this species, I believe, has not been yet described, I have sketched its characters.

* *Vide* Annals and Mag. Nat. Hist., New Ser., vol. ii. p. 628; Trans. Ent. Soc. ii. 65; Gardeners' Chron. vol. x. p. 340, and an interesting detail of the economy of *M. domestica* (the House Ant) by Mr. Daniell, in the Proceedings of the Linnean Society, vol. ii. p. 172.

† There are many beetles thus introduced into granaries and mills, and from the sacks lying there carried with the flour into our bake-offices, and thus introduced living and dead into our private dwellings.

‡ Mr. Westwood's figure of the superior wing does not quite agree with mine; in his wing the apical cell is subtrigonate and closed, and the second marginal cell is also extended to the edge, so as to form a closed space.

15. S. albipennis, Curtis.

Male very black and shining; head dull, indistinctly punctured; mouth ferruginous: antennæ tawny, dusky at their tips, the scape and second joint ferruginous, the latter stouter than the third; and elongate obconic. Thorax indistinctly and irregularly striated; scutel large and glossy; postscutel convex, delicately punctured, with the angles scarcely visible. Petiole elongated, basal joint clavate, second subglobose: abdomen small, ovate-conic, the tip ochreous. Wings with a pale fuscous-yellow stigma, the nervures almost invisible. Legs long and slender, ochreous-white; the coxæ, thighs and tibiæ pitchy, except at their extremities: length $1\frac{1}{3}$, expanse 3 lines.

Female undiscovered.

Neuter smooth pale reddish ochre: head large, oblong, convex, finely striated, the margin and clypeus more or less fuscous; mandibles ochreous. Antennæ stout, and ochreous, scape long, second joint stoutish, elongated, third and six following very short, transverse and increasing in diameter, the three last joints forming a stout fuscous club. Thorax much narrower than the head, indistinctly striate-punctate, oblong, narrowed at the middle; postscutel producing two distinct acute divaricating dark spines. Petiole stoutish, with a few hairs, basal joint elongate-clavate, subrugose, second globose: abdomen small, very polished, with a few short scattered hairs, ochreous, brown beyond the middle, the apex ochreous. Legs short, stout, and ochreous: length 1 to $1\frac{1}{4}$ line.

The male of this species greatly resembles that of *S. Westwoodii*, but independently of its smaller size and somewhat different sculpture, the postscutel has only two minute points, which are scarcely visible; the tarsi, especially the hinder, are white in some lights, and the nervures of the wings are difficult to discern.

The only evidence I have of the above insects being the males and neuters of one species is my having discovered them together. I beat two males and two neuters out of a Privet hedge, the 31st July 1852, on the Folkestone road near Dover. At first I considered the neuters to be small varieties of *Myrmica unifasciata*, but on obtaining typical specimens at Pau, the difference was manifest; the dark band on the body of that species covering more than half the basal segment, whilst the antennæ are entirely fulvous. This strong resemblance however leads me to think that its male may be similar to the same sex of our species, and consequently that it may be a *Stenamma*, as previously intimated.

Myrmecina, Curtis.

16. M. Latreillii, Curt. Brit. Ent. fol. and pl. 265 ♂; *graminicola*, Foerst. Hymen. Stud. p. 58 ♂.

Male smooth shining pitchy black, slightly hairy. Head broad, ocelli very prominent, the anterior one with a little fovea in front: mouth ochreous: antennæ longish, geniculated, 13-jointed, tawny, and slightly thickened towards the apex. Thorax gibbose, the sutures forming large deep channels; scutel prominent; postscutel finely striated and producing two short sharp divaricating spines. Petiole stoutish, basal nodule elongated, second subglobose: abdomen ovate-conic. Wings entirely fuscous, stigma and nervures

brown. Legs tawny, thighs and tibiæ pitchy, except at the extremities: length $1\frac{1}{3}$, expanse $3\frac{1}{2}$ lines.

Female (fig. 22) black: head suborbicular-quadrate irregularly striated, clypeus bidentate (fig. 23); eyes and ocelli minute, mouth ferruginous: mandibles large and prominent, with many minute teeth; neck distinct, ferruginous: antennæ remote, not long, stoutish, geniculated, 12-jointed and clavate, scape long, second joint cup-shaped, seven following transverse, the third being very short, the ninth much longer, the remainder forming a club, the apical joint being long and conical (fig. 24). Thorax not so large as the head, obovate, hollowed and striated before; the scutel, which is smooth, has the suture at the base ferruginous; postscutel very short, punctate, with two short but distinct spines (figs. 25 and 26 *b*). Petiole ferruginous, elongated, hairy, basal nodule subquadrate or ovate, second broader, transverse, and partially striated (figs. 25 and 26 *i*): abdomen very smooth and shining, rather broad, slightly depressed and oval, the apex ferruginous. Wings fuscous, exactly like the male. Legs ferruginous, stoutish, especially the anterior, which are rather short: length $1\frac{2}{3}$, expanse nearly 4 lines.

Neuter undiscovered.

This species, which I dedicated to my esteemed friend Mons. P. A. Latreille, is quite distinct from any other type of the *Formicidæ* that has fallen under my observation. It is now twenty-five years at least since I discovered the males near that romantic spot, Black Gang Chine in the Isle of Wight, but I have since found others near Greenwich, towards the end of August; and at Sandgate in Kent, in October. It was not till August 1836 that I had the satisfaction of taking, what I consider to be, the female of this insect, at Lulworth Cove. It is remarkable that Mr. F. Smith should have caught a female also in Camden Town, on the wing, and as he has also found the male at Colney Hatch, it seems to be generally distributed in the southern counties. It appears to affect swampy localities, for all the males I have taken were flying about and settling upon rushes, and my female was captured close to a spot where rushes and reeds were growing.

As it is inconvenient to retain useless names, it is advisable to state that *Myrmica binodis* must be expunged from our British lists, and of the eleven *Formicæ* recorded in my Guide*, there are only eight which are ascertained to inhabit Great Britain. No. 1. *F. pubescens*, Latr. and No. 8. *F. emarginata*, Oliv. were admitted on doubtful authority, and No. 11. *F. cognata*, Steph., is not to be found in the British Museum, where Mr. Stephens's collections are deposited.

* Curtis's Guide to an Arrangement of British Insects, 2nd Edition; Genus 661.

EXPLANATION OF THE PLATE.

TAB. XXIII.

Fig. 1. Antenna of *Myrmica rubra*, Linn. ♂.
Fig. 2. Mandible of ditto.
Fig. 3. Maxillary Palpus of ditto.
Fig. 4. Mentum and labial Palpus of ditto.
Fig. 5. Antenna of *Myrmica rubra*, Linn. ♀.
Fig. 6. Mandible of ditto.
Fig. 7. Antenna of *Myrmica rubra*, Linn. ☿.
Fig. 8. Mandible of ditto.
Fig. 9. Maxilla and Palpus of ditto.
Fig. 10. Mentum and Palpus of ditto.
Fig. 11. Head of *Myrmica longiscapus*, Curt. ♂.
Fig. 12. Antenna of ditto.
Fig. 13. Superior wing of ditto.
Fig. 14. The petiole and postscutel of ditto in profile.
Fig. 15. *Myrmica perelegans*, Curt. ♂.
Fig. 16. Ditto ♀.
Fig. 17. Ditto ☿.
Fig. 18. *Myrmica denticornis*, Curt. ♂.
Fig. 19. Ditto ☿.
Fig. 20. Antenna of ditto.
Fig. 21. Wing of *Stenamma Westwoodii*, ♂.
Fig. 22. *Myrmecina Latreillii*, Curt. ♀.
Fig. 23. Head of ditto.
Fig. 24. The antenna.
Fig. 25. The scutel, postscutel, and base of abdomen.
Fig. 26. The same in profile.

Obs. The lines and cross lines show the natural dimensions of the different species represented.

Belitha Villas, Barnsbury Park,
7th March, 1854.

J. Curtis, ad nat: del[t]. Feb. 1854.

Fred[k] Smith. Sculp[t]

XXIV. *Note on the Elaters of* Trichia.

By Arthur Henfrey, *Esq., F.R.S., F.L.S. &c.*

Read February 7, 1854.

THE existence of spiral fibres in the filamentous *elaters* mixed with the spores of *Trichia* and some allied genera of Fungi, is a fact so remarkable, that, since attention was drawn to it by Corda, it has been mentioned in almost every notice on the general structure of the lower Cryptogamia. Had it not been recently called in question by two distinguished vegetable anatomists, I should not have ventured to occupy the attention of the Society with the matter, when I have only time and opportunity at present to describe the condition in a single species.

Hedwig the younger (1802) was the first to point out the existence of the spiral fibres, in three species of '*Lycoperdon*,' which Schlechtendahl identifies as *Trichia rubiformis*, Fries, *T. chrysosperma*, Fries, and a *Diderma*. In looking over the Ratisbon 'Flora,' I find a passage in a paper written by Kaulfuss, on *Targionia*, in 1822, in which that author says, "according to my investigations, the structure of the so-called capillary tissue of the Trichiaceæ is exactly the same as that which we find in the elaters of the Hepaticæ." So that apparently Corda was the third, and not the second, observer of the fact, as is generally imagined. Corda first made it known in an essay published at Prague in 1837, having in the same year brought it before the Association of German Naturalists, at their meeting in Prague. Schnitzlein has figured the structure in his 'Iconographia,' and a notice on the subject, without figures, but asserting the existence of the spiral fibres, was published by Schlechtendahl in the 'Botanische Zeitung' of May 4th, 1844.

On the other hand, Schleiden, in the most recent edition of the 'Grundzüge der wissenschaftliche Botanik,' says (ii. 41) that observations, recently repeated, have perfectly convinced him that the appearance of spiral fibres arises from the twisting of a flat band; while Schacht, in his 'Pflanzenzelle,' declares (p. 151) for the same view. Schleiden gives no figures, but Schacht draws fragments of elaters from two species of *Trichia* (pl. 16. figs. 13 and 14); but his figures completely contradict the statements in the text, for they give appearances which could not possibly arise from the twisting of a flat band.

Having carefully examined the elaters of *Trichia* (*serotina*, Schrad. ?) in some specimens sent home to the Society by Mr. Ralph, from New Zealand, I am prepared to assert positively the existence of spiral fibres, exactly analogous to those in *Marchantia polymorpha*; the number of fibres in an elater of this species of *Trichia* is three. Corda describes a much greater number in some species, but I think that point is open to doubt. The fibres thin off towards the very gradually attenuated ends of the tubular elaters, and apparently become confluent there, in the same manner as I described in *Marchantia polymorpha* (Linnean Transactions, vol. xxi. p. 107), but the ends are so fine that even

with a power of 1000 diameters and a good light I could not clearly define the terminations of the fibres.

My observations as to the tubular character of the elaters, were decisive even before clearly defining the fibres, since I could obtain a transverse sectional view in certain curved filaments, which gave a circular form; the spiral structure was clearly distinguishable with a power of 250 diameters; but, in order to count the fibres, it was necessary to take out a few elaters and mount them in the thinnest possible film of liquid, under very thin glass, and apply a magnifying power of 1000; then the individual fibres could be made out quite clearly enough to allow of their being drawn with the camera lucida.

These elaters may be regarded as very good test objects for the defining power of the higher object-glasses; or, perhaps,—considering the confusing effect of the crossing curves of the different parallel spiral fibres,—as test objects by which to measure the value of observations on the more difficult tissues. If we take them in this light, it must follow that either the microscopes or the observing powers of Schleiden and Schacht are imperfect, and since the latter certainly is not the case, the conclusion is that observations on very highly magnified bodies made by these observers, must be received with great caution until they provide themselves with better instruments.

Postscript.

Since the above was written I have received some information on the subject from the Rev. Mr. Berkeley, who fully agrees with me as to the existence of spiral fibres. Mr. Berkeley directed my attention to the fact that Schmidel (Icones Plantarum) had pointed out the existence of this structure in 1762; thus many years before the younger Hedwig. I may transcribe Mr. Berkeley's remarks on Schmidel's figure:—"Spiral filaments do not exist in *Arcyria pumicea*, the species which Schmidel has in view in tab. 33; but he has mixed up with it some *Trichia*, figured in figs. 4, 12, 13, 14, 15, 16; and a careful examination, with a lens, of fig. 16, and a reference to the text will show that Schmidel was perfectly aware of the structure." In the copy in the British Museum I find the spiral fibre of fig. 16 quite clear, without magnifying the drawing.

"*Cribraria purpurea* is represented at the lower part of the same plate: no spiral filament, so far as I have observed, exists in this species, nor can I, on a re-examination of the fungus this morning, find any such appearance as that represented by Schmidel at fig. 8. It is possible however that he may have had one of the red *Trichiæ* intermixed with his *Clathrus stipitatus*, for his description is too circumstantial to allow of a supposition that so correct an observer could make so palpable a mistake." Mr. Berkeley inclosed a specimen of this fungus with the filaments, and I also find no spiral filament.

"Schmidel did not detect the structure in the species figured at his tab. 24, if that is a real *Trichia*." He here represents the filaments as moniliform (fig. 7). Mr. Berkeley also reminded me of his own discovery of threads with a single spiral fibre in *Batarrea* (Hooker's Journal of Botany, ii. tab. 22. fig. 1, 1843).

Mr. Berkeley very truly says in his note, that Schacht's own figures contradict his text. He gives a spiral or screwed appearance with *three* threads, which could not possibly result from the twisting of a flat band; this could only present *two* threads formed by its

two edges. The *appearance* of the spiral fibres is very clear with low powers, yet I do not consider that they are sufficient to prove the actual structure; but a very high power in my opinion renders it unmistakeable, while the fact of obtaining the free ends of the fibres in an elater broken across, puts the question beyond doubt.

EXPLANATION OF THE FIGURES.

Tab. XXIV.

Fig. 19. Spiral fibres in Elater of *Trichia* (*serotina*, Schrad. ?), magnified 1000 diameters.

Fig. 20. Another view of the same.

Fig. 21. Ideal diagram of the same.

XXV. *Note on the Genus* Ancistrocladus *of Wallich.* *By* G. H. K. Thwaites, *Esq., F.L.S. &c., Superintendent of the Botanic Garden of Peradenia, Ceylon.*

Read February 21, 1854.

HAVING recently had opportunities of examining the structure of the flowers of *Ancistrocladus Vahlii*, as well as its fruit in various stages of development, I have been enabled to arrive at a more correct knowledge of their structure than appears to have been previously within the reach of botanists who have described species of this genus, and there would seem to be now little room for uncertainty as to where the genus should be located.

The circumstance of the fruit of *Ancistrocladus* being surmounted by the enlarged segments of the calyx has led to the genus being introduced by different botanists into the several families of *Combretaceæ*, *Malpighiaceæ* and *Dipteraceæ*; from all these, however, it essentially differs in its seeds being albuminous.

With the *Symploceæ* it seems to me that *Ancistrocladus* would associate better than with any other group of plants, agreeing with them in its undivided exstipulate leaves, its character of inflorescence, imbricated calyx and corolla, persistent calyx, stamens adhering to the base of the corolla, inferior ovary, albuminous seeds and cylindrical embryo. From *Symploceæ*, however, it differs in its scandent habit, its calycine segments becoming enlarged, its solitary erect ovule, and the peculiar structure of its albumen.

With the *Myristiceæ* and *Anonaceæ*, *Ancistrocladus* would seem to have some slight affinity, its only ovule recalling to mind that of *Myristica*, and the embryo not being very dissimilar in the two genera; whilst the scandent habit and uncinate ramuli give *Ancistrocladus* some considerable resemblance to *Artabotrys*.

The following generic character has been drawn up from an inspection of fresh specimens of *Ancistrocladus Vahlii*, Arn., and from the figure of *Ancistr. Heyneanus*, Wall., in the last volume of Dr. Wight's admirable 'Icones Pl. Ind. Orientalis.'

Genus *Symploceis* affine.

Ancistrocladus, Wallich. *Wormia*, Vahl. *Bigamea*, König.

Flores hermaphroditi. *Calyx* tubo cum ovario connato; limbo 5-partito; laciniis oblongis, inæqualibus, imbricatis, tribus majoribus, omnibus increscentibus, persistentibus. *Corollæ* petala 5, æqualia, concava, basi connexa. *Stamina* 5, imæ corollæ inserta, petalis alterna, (in *Anc. Heyneano* stamina 10 in seriebus duabus). *Filamenta* basi incrassata, monadelpha, apice cuspidata; *antheræ* adnatæ, biloculares, longitudinaliter dehiscentes; loculis basi divergentibus. *Ovarium* inferum, 1-loculare. *Ovulum* unicum, erectum, anatropum. *Stylus* subglobosus, persistens. *Stigmata* 3, erecta, linearia, compressa, truncata, decidua. *Nux* coriacea, calycis laciniis coronata. *Semen* cerebriforme, erectum; testâ plicato-intricatâ, albumen carnosum plicis involventi. *Embryo* orthotropus, clavatus; *cotyledones* subfoliacei, divergentes; *radicula* prope hilum posita.

Frutices *indici et zeylanici, soboliferi, scandentes*; ramis *elongatis, teretibus*; ramulis *brevibus, patentibus, uncinatis*; uncis *circinatis, sub nodis ramulorum positis, internodia terminantibus*; foliis *lanceolatis, utrinque angustatis, sessilibus, integerrimis, lævibus, penniveniis, densè reticulatis, in ramos distantibus, ad ramulorum apices aggregatis, vernatione convolutis*; inflorescentiâ *axillari, racemosâ*; racemis *plùs minùsve ramosis*; pedunculis *angularibus paucifloris*; floribus *alternis*; pedicellis *brevissimis, rachi articulatis*; bracteis *minutissimis.*

The *Ancistrocladus Vahlii*, W.-Arn. (*Wormia hamata*, Vahl, C.P. No. 1600 in Herb. Peradeniensi), is very abundant in some of the warmer districts of Ceylon, and owing to its spreading so much by its roots, is a very troublesome weed to the cultivator. Its Cinghalese name is *Gonawel* or *Gonapittanwel.*

DESCRIPTION OF THE PLATE.

Tab. XXIV.

Fig. 1. Unexpanded flower of *Ancistrocladus Vahlii*, Arn.
Fig. 2. Flower with the corolla and stamens removed.
Fig. 3. Corolla and stamens.
Fig. 4. Stamens.
Fig. 5. Longitudinal section of ovary, showing the single erect ovule.
Fig. 6. Ovule removed.
Fig. 7. Longitudinal section of ovule.
Fig. 8. Early development of the seed, where the testa has become slightly rugose.
Fig. 9 & 10. Somewhat later development of seed, the testa becoming plicate.
Fig. 11. Still later development of seed.
Fig. 12. Still later development of seed.
Fig. 13. Still later development of seed.
Fig. 14. Longitudinal section of ripe seed, showing the embryo in position.
Fig. 15. Embryo removed.
Fig. 16. Portion of the brittle albumen invested with the plicæ of testa.
Fig. 17. Longitudinal section of immature fruit.
Fig. 18. Longitudinal section of mature fruit.

XXVI. *Remarks relative to the affinities and analogies of natural objects, more particularly of* Hypocephalus, *a Genus of* Coleoptera. *By* JOHN CURTIS, *Esq., F.L.S. &c. &c.*

Read April 4, 1854.

THE number of extraordinary new forms, which have been discovered of late years, has led to a great deal of speculation regarding their position in the scale of nature. This has been exceedingly useful and instructive, although often very perplexing, and I fear that we not unfrequently take the shadow for the substance, mistaking analogies for affinities. The curious, indeed wonderful insect, which Mr. White exhibited and commented upon at a recent meeting of the Linnean Society, will be my apology for offering any remarks upon the subject.

The affinities of natural objects have been supposed to form a chain, a net, or a series of circles, the last composed of certain definite numbers of types, &c. These ingenious systems have been ably discussed by talented men*, but they have not made a lasting impression, owing probably to the multitude of exceptions that occurred and the gratuitous assumptions necessary to fill up the vacuum occasioned by absent members. We all know that "the Natural System" has been long an object of pursuit, which I expect we shall never overtake. The truth appears to be, that there is no perfect natural system, according to our limited notions; and it will be a stumbling-block to those who think otherwise, to find that where a few links are forthcoming, which unite certain groups, there are a vast number more discovered, which disturb what promised to be with fewer materials a complete arrangement. Thus we have lines broken, circles not meeting, most curious types presenting themselves to augment infallible numbers, and to be dismissed by the theorist as inconvenient intruders. No doubt there is a plan in Creation which is not revealed to us; but to study, write upon, and understand a subject, we must form a system (imperfect though it be), in order to methodise and arrange our materials as they are collected; and to accomplish this, we must be contented with chains which are continuous, of unequal lengths, either running entirely parallel, or converging, or diverging, but forming Stirpes or Families which harmonise, are easily comprehended, and exhibit various lines of relationship or resemblance.

In searching for a natural system, we seek for perfect unity or harmony, which being frequently interrupted, we fail in our object, and are disappointed. No doubt harmony, having a divine origin, pervades all creation; but it is manifest that there are also disturbing forces which interfere with that first principle. Even amongst the heavenly bodies, comets in their eccentric course seem to us destined to effect changes in that otherwise perfect harmony. In this Planet which we inhabit, we have abundant evidence, probably

* Vide the Essays of MacLeay, Horsfield, Vigors, Swainson and Newman.

of their agency, but at all events of disturbing forces, which have apparently succeeded one another from the beginning of the world, and are active still. We ought not therefore to be more surprised at finding systems not to be perfect, than we are to find that sound is not free from discord, nor form from distortion.

Perfection seems to be equivalent to harmony; and this as regards form, which most concerns us at present, was best understood by the Greeks. It consists of a combination of parts, whose relative proportions are so perfectly in harmony in every respect, that the object becomes pleasing to the eye, even when uncultivated; it leads the mind to the contemplation of a type of grace and beauty exceeding our daily experience, and thus the Grecian sculpture has become the standard of taste. The human heart is greatly affected by harmony: Poetry, Music and Painting bear ample testimony to its influence. Order and arrangement are component parts of harmony, for without them no system could exist.

A knowledge therefore of the component members of bodies and the harmonious combination of them is, or ought to be, the basis of all arrangements, and the closer we keep this in view the more true to nature, and the more satisfactory will the system be, because it will make everything subservient to true affinities. But in our progress to establish a system we are sure to find disturbing forces, producing aberrant types of form, which like discordant notes in music, will not chime in anywhere; they are too flat for some chords, too sharp for others, and are thought to be anything but consistent with our notions of what is natural. Now to this description of animals belongs the anomalous beetle which Mr. White introduced to us, and which he has been so obliging as to allow me to examine at my leisure. It has received the name of *Hypocephalus*, and resembles so many individual members of different families, yet agreeing with none, that it has from its first discovery been a subject of speculation, in which M. Desmarest, Dr. Gistl, Dr. Burmeister, M. Guérin-Méneville and Mr. Westwood have taken part.

I should say, it has the head of a Tortoise, the tusks of a Walrus, the legs of a Kangaroo, and certainly the strength of a giant; probably a hundred times greater in proportion to its size than that of an Elephant. Amongst Insects it has been likened to the Mole-cricket, and so deceptive are analogies, that when I first beheld the *Hypocephalus* at Florence, I thought it was a gigantic *Brenthus**. M. Desmarest considered it allied to the *Silphidæ* or Grave-digging beetles, and Dr. Burmeister and Mr. Westwood are agreed that it is allied to the *Cerambycidæ*. Were it not for the deficiency in the number of the palpi, there would be no difficulty in associating it with the *Scaritidæ*: the head and legs being very like those of *Pasimachus*, and the antennæ being nearly those of *Psammophilus*; whilst the robust legs, large head, ample postpectus and remote hind legs of *Caladroum* (a New Holland *Carabus*) at once exhibit a great resemblance†.

It is evident, in making any attempt to associate an aberrant form with a natural family, that great caution is necessary, not to be influenced by analogy, beyond what it is worth,

* It is remarkable that some of the *Brenthidæ* have the hinder angles of the head produced in the male, as in *Arrhenodes*, where they form lobes, smaller in proportion, but of the same character as those exhibited in *Hypocephalus*, which would altogether indicate a similarity of economy.

† Vide also *Clivina*, and *Broscus*; and *Promecoderus* has quite the form of a pigmy *Hypocephalus*.

for a single proof of affinity must be preferred before an assemblage of analogies. This leads me to question the views of my friend Professor Burmeister, regarding the relationship of *Hypocephalus* with the *Prionidæ*, for after a careful investigation I am constrained to believe, that the former genus is more related to the *Lamellicornes*, and for the following reasons, which I will give in a tabular form, the better to contrast the claims of *Hypocephalus* to be associated with either of those Families.

The LAMELLICORNES	The LONGICORNES
are Pentamerous.	are Tetramerous.
Mouth with 4 Palpi, quadri- and tri-articulate. Mandibles often corneous.	Mouth with 4 Palpi, quadri- and tri-articulate. Mandibles always corneous.
Antennæ short, capitate, or clavate, often with many moniliform joints.	Antennæ elongated, not moniliform.
Eyes small, round or oval.	Eyes emarginate.
Elytra horny or coriaceous.	Elytra horny or coriaceous.
Legs, hinder not unfrequently incrassated.	Legs, hinder not incrassated.
Tibiæ thick, dilated, 4 anterior emarginate externally, forming teeth or lobes; apex with minute spurs.	Tibiæ dilated, generally compressed, not emarginate externally.
Tarsi simple; anterior short and a little dilated. All five-jointed.	Tarsi, penultimate joint generally bilobed, sometimes with a head, or false joint at the base of the terminal one. All four-jointed.

After this simple comparison, let us take a more general view of the character. In no family of beetles is the thorax so fully developed as in the *Scarabæidæ*, and the legs are almost universally robust. In *Melolonthidæ*, as indeed in all the *Lamellicornes*, the tibiæ are more or less lobed or toothed outside*. In *Chrysophora* and *Pelidnota*, in *Ripsinus*, *Dichelus* and *Pachycnema* we find the hinder legs very much larger than the other four; the thighs are very much incrassated, the tibiæ often curved and toothed, whilst the genus *Hexodon* proves what extraordinary departures there are from the typical forms. When we arrive at the *Lucanidæ* we find a description of mandibles that singularly accords with *Hypocephalus*, especially in *Pholidotus* and *Orthognathus*, whilst the eyes are small, remote, and placed behind the antennæ. The labrum and labium are generally invisible after death, and the maxillary lobes are very small, whilst the palpi are well developed, as in *Platycerus*, the typical *Lucanidæ*, &c.

Let us now turn to the apparent likeness between *Hypocephalus* and the *Longicorns*. In approaching that Family we find *Passandra*, which bears some resemblance to *Hypocephalus* in the form of the head and antennæ, and in the position of the eyes, but the legs are remarkably small; *Passandra* however is considered to form one of the links to *Parandra* (which may be termed a tetramerous *Lucanus*), and making an approach to *Hypocephalus*, but the characters of the mouth, eyes, and tarsi, will not support any claims to affinity†. Next comes *Spondylis*, which in the form of the antennæ and the proportions of the palpi, agrees with *Hypocephalus*, but the mentum is not trilobed, the

* Vide *Copris*, Curt. Brit. Ent. pl. 414; *Geotrupes*, pl. 266, *Aphodius*, pl. 27, also *Melolontha*, *Cetonia*, and *Lucanus*.

† I may add that I consider *Trictenotoma* a Heteromerous Lucaniform beetle, not a Longicorn.

eyes are dissimilar, the tarsi tetramerous* and of a different character, being all equally long and dilated. Another genus, *Cyrtognathus*†, is apt to confound our notions of analogy and affinity, but in truth it bears only a resemblance to *Hypocephalus*, principally owing to the elongated head, and the mandibles being bent down like a beak, with lateral protuberances, and well-developed palpi‡. For the eyes are very large, and reniform, being deeply emarginate, approximating, indeed almost meeting on the crown: the head is not dilated at the base, having no angles, far less any lobes: the antennæ are very long and curling, more than half the length of the insect, and 12-jointed, the joints compressed, completely serrated, the third joint very long: the thorax is broader than long, the sides angulated, with a large conical porrected spine at the base of the antepectus, between the anterior coxæ; the postpectus not unusually large; the coxæ approximating in pairs: the scutellum typical and triangular. Elytra more than twice, in some specimens nearly thrice, as long as the head and thorax united. Wings ample. Abdomen as large as the postpectus. Legs very long, stoutish, compressed: thighs stout, but not incrassated: tibiæ long, especially the hinder, straight, not dilated nor lobed, but the first pair are spiny; all with a pair of acute spurs at the apex, *longest* in the *hinder* pair: tarsi tetramerous, nearly of equal length, the two anterior pair depressed, dilated, and very pilose beneath, 3rd joint bilobed, terminal joint long and clavate, with a minute spurious joint forming the base; the joints in the *hinder* pair with their angles spiny, and two series of hair beneath: claws long, curved and sharp. It is an inhabitant of Mongolia, considerably to the north of the Equator.

It would be unreasonable to deny that there is a very considerable analogy existing between *Hypocephalus* and *Cyrtognathus*, but if we look to the antennæ having 12, instead of 11, joints, to their great length and relative proportions, as well as to the situation, magnitude, and form of the eyes, the size and figure of the thorax, the scutel, sternum and elytra; having wings for flight; to the long sprawling legs, neither robust nor truly 5-jointed, to the long simple tibiæ, the dilated and bilobed and spongiose tarsi, it is impossible to allow that there is any affinity. *Cyrtognathus* is a *Longicorn*, *Hypocephalus* is not§.

I must no longer defer giving an ample, and I trust faithful, description of

HYPOCEPHALUS, Desmarest‖. Tab. XXV. fig. 1.

Head elongated (f. 2 & 3), with 2 large vertical conical lobes on each side of the mandibles (*l*), the crown flattened and terminating abruptly at the base, which is dilated, the angles very much elongated and

* The minute joint at the base of the terminal joint, if accepted, renders it pseudo-pentamerous.

† Zool. Journ. vol. ii. pl. 19. f. 4. *Dorysthenes rostratus*, Vig.

‡ I am under the necessity of regretting my inability to compare the trophi satisfactorily for want of specimens to dissect, which prevents me from doing full justice to the subject. I can however see enough to convince me that the labrum, mentum, and proportions of the palpi are very different in those two genera.

§ As *Cyrtognathus* was the insect exhibited by Mr. White to confirm the supposed affinity of *Hypocephalus* with the *Cerambycidæ*, it was necessary to enter fully upon the investigation of that insect. Since this paper was read he has adduced another insect, named *Baladeva Walkeri*, in support of his views.

‖ Guér. Mag. Zool. Class IX. pl. 24, and Westw. Arcana Entomologica, vol. i. p. 35, pl. 10 and p. 111.

forming slender subclavate lobes. Eyes placed behind the antennæ, lateral, oval, oblique, protected in repose by the projecting margin of the crown, moderately convex, and finely granulated. Antennæ (f. 4 & 1 *a*) remote from the base, inserted behind, and at the base of, the anterior lobes of the head, glossy, depressed beyond the middle, sparingly clothed with depressed hairs on all sides, much shorter than the head, 11-jointed, basal joint oval, the longest and stoutest, 2nd the smallest, cup-shaped, 3rd obovate, truncate, longer than the following, which are cup-shaped, distinctly articulated, almost imperceptibly increasing in diameter to the middle, being slightly produced on the inside and diminishing to the extremity, apical joint somewhat obcordate. Underside of head (f. 1) exceedingly polished, the sides punctured, rugose, the lines from the hinder lobes emarginate, leaving a large triangular space, when the head is porrected (*s*), membranous in the centre and striated transversely, with a circular cavity before the middle, the sides irregularly striated, pubescent at the base. Eyes not visible from beneath†. Labrum invisible ("petit, triangulaire," *Desm.*). Mandibles strong (*m*), porrected, slightly drooping, parallel, conical yet flattened, with a large tooth on the outer margin. Maxillæ invisible: Palpi (f. *p*) long and stout, inserted immediately under the mandibles, hairy and rough at the base, attached to 2 minute scapes, 4-jointed, slightly pilose at the extremities, 2 basal joints clavate, elongated, 1st a little the longest and stoutest, 2nd clavate, 3rd obovate truncate, 4th a little the broadest, axe-shaped, being truncated obliquely, the apex spongiose. Mentum (f. 4*) transverse-oval, the margin trilobed, the central lobe trigonate, the lateral lobes pilose. Palpi (*p*) nearly as long as the maxillary and very similar in form, attached to two approximating scapes, triarticulate, basal joint longest and the stoutest, 2nd nearly as long, 3rd axe-shaped, truncated obliquely. Thorax very large, egg-shaped, very convex and smooth, sides margined, anterior margin ciliated, with a deep and broad channel before, formed by the base of the head; hinder margin concave before the pseudo-scutellum which is large, trigonate, very rough, the apex shining and somewhat acuminated, with a slight ridge down the centre. Anterior margin of the antepectus forming a large triangular space (f. 1. *s*), the point terminating in a semicircular cavity, the margins with a row of 6 trigonate blunt teeth on each side, becoming broader as they approach the head, the whole like the molars of an elephant, and ciliated internally with short stiff hairs. The sternum forms a long, linear, deeply channeled lobe, between the coxæ, the apex very dilated, cordate, with a very elevated ridge in the centre, like a nose in profile (*a. p*): postpectus very ample, forming an emarginate lobe between the middle pair of legs; posterior margin very sinuated before the hinder coxæ, the lobe between them tongue-shaped, the margins thickened (fig. *p. p*). Elytra scarcely so large as the thorax, very convex, margined, acuminated, connate, the base depressed and the sides forming slightly raised angulated plates; coriaceous, rugose, with 4 slightly raised thread-like, oblique, longitudinal lobes. Abdomen very small, trigonate-conic, 5-jointed, very smooth, the sides and apex alone edged with pubescence. Legs enormously stout and powerful, especially the hinder pair: coxæ received into large orbicular sockets, globose or conical, trochanters subovate, the hinder forming large conical prominent lobes or spines: Thighs short and stout, anterior the shortest, hinder the largest, scooped out beneath and forming a flattened tooth on the outside, near the middle; apex deeply notched: tibiæ very strong, somewhat flattened and dilated, longer than the thighs; anterior with a large lobe on the outside of the apex and another at the middle, with 2 strong spurs on the inside of the apex: middle pair similar but a little longer, spines the same but smaller, the truncated apex ciliated: hinder pair the longest, less dilated, very much incurved, compressed towards the apex, which forms a claw on the under side, with a small tooth inside; it is truncated obliquely, forming a heel above, and densely clothed with fulvous soft hairs: tarsi 5-jointed, long, slender; anterior the shortest (f. 5), a little dilated, basal joint elongated bell-shaped, 2nd somewhat cup-shaped, 3rd smaller, 4th the smallest, all the angles produced into teeth; underside smooth, excepting 2 lines of hairs on

† In Mr. Westwood's figure they are visible.

the basal joint beneath: middle pair almost as long as the tibiæ, basal joint equal in length to the three following, clavate, 2nd and 3rd somewhat obovate, 4th the smallest, obtrigonate, all truncated, concave beneath, with a spine at each angle, basal joint with 2 series of hairs beneath, 5th joint elongate, clavate, produced into a semicircular horny plate on the underside: hinder pair with the basal joint much shorter than that of the middle pair; claws not large but curved and acute.

Fam. XENOMORPHÆ, Gistl. *Mesoclatus paradoxus*, Gistl.

HYPOCEPHALUS ARMATUS, Desmarest? Pitchy: head and mandibles with scattered punctures: palpi and antennæ castaneous. Thorax black, with faint scattered punctures, stronger round the margins: scutel with the base densely punctured, and opake black, apex punctured but shining, and forming a smooth line to the base. Tibiæ punctured, especially above, the hinder rugose; tarsi castaneous; claws black; apex of coxæ and trochanters inclining to castaneous. Abdomen with an ochreous membranous line at the base of each segment. It is 2½ inches long*; the thorax about 10 lines broad.

There are so many differences between M. Desmarest's figure and Mr. Turner's specimen†, that in all probability they are, if not distinct, the sexes, this being a male I presume. My descriptions and figures may assist in settling this question, and I trust they will prove serviceable in illustrating the history of this anomalous beetle, as well as lead to a careful examination, in living specimens, of the extraordinary apparatus under the head, which may also be a sexual character.

Before further discussing the position of *Hypocephalus* I will attempt to complete its history as far as I am able, but at present I can only conjecture its habits by analogy.

Many specimens of this beetle have been found in the mining districts of Brazil, considerably south of the Equator. Three are reported to have been met with in the carcase of a dead horse, and others creeping upon the ground. It is also stated to live in rotten wood in forests. There is every reason to believe that *Hypocephalus* is a burrowing insect, and probably lives underground. Its attenuated form is admirably adapted to forcing its wedge-shaped head into any crevice, with an incredible power of resistance in the hind legs, and its tapering behind is no less calculated to enable it to retreat, folding its enormous limbs by the sides of its small body. Under such circumstances one would expect to find unusually small antennæ, which readily fall back and beneath the head, for protection. Wings of course are useless, whilst its connate or soldered elytra give additional solidity to the body, and their partial separation allows of an expansion of the abdomen, under great exertion or pressure.

The fore feet, like those of other burrowing insects, are fitted for scraping, clearing away the refuse, and passing it backward. The lobed jaws probably fit into the wonderful apparatus at the base of the head, and together with the protuberances on either side seem to form an instrument for grinding its food, which may then be deposited until required in the pouch, which looks indeed like a ruminating stomach. The mandibles are formed for clawing and pulling, or tearing, and the two rows of teeth, like the molars of an ele-

* Mr. Westwood's specimen is 3½ inches long.

† This example had broken feet, as my figure shows, and probably it was aged, or dead when found; young and perfect specimens may have longer and sharper spines and more hairs upon the limbs.

phant, are evidently for grinding or mastication, the jaws by themselves being useless in that respect, yet I expect they are capable of lateral motion.

Having shown that this pentamerous beetle agrees with the *Lamellicornes* in various ways, whilst it disagrees with the *Longicornes* in many, I will assign my reasons for associating *Hypocephalus* with the former Family, even were the claims balanced, excepting the tarsi.

I confess that I have still so good an opinion of the tarsal system of Geoffroy, and adopted by Latreille, as a basis for the primary divisions of the *Coleoptera*, that I do not hesitate to challenge any systematist to exhibit another, better, more useful, or less objectionable*. It is usual to term this an artificial System, but that which is based upon anatomy is no more artificial in Entomology than in any other Class of animals, and the skeletons of Insects being external, the joints of the legs and feet are as purely anatomical as the bones (the femur, tibiæ, &c.) of any quadruped or bird. In pursuing the tarsal system, no one will attempt to deny meeting with many exceptions to the general type of form, but these occur in the minuter groups, which often seem to become feeble in their development, and depart from the perfection, if I may so term it, exhibited by the large and typical species. In the Family *Staphylinidæ*, for example, the number of joints varies in the feet, but this is confined to the minute species†, and to an amount so small, that it cannot justify our abandoning so valuable and tangible a character for dividing the enormous Order Coleoptera. And when we examine the large and perfectly-developed examples, which must decide the position of a Family, we find the *Staphylinidæ* an undoubted pentamerous group‡; the larvæ also in this instance assimilating so well with those of the *Carabidæ*, that it is at present difficult to decide to which family they belong.

My experience teaches me, that as regards affinities, animals do not descend in their claims of relationship, viz. If the types of a group exhibit certain perfections in their structure, that group has no absolute affinity to a family typically less perfect, and cannot therefore be transferred to that inferior group, without doing a violence to nature's laws. For instance, it would be unnatural to remove a member of the Family *Carabidæ*, with its 6 palpi, to any other less perfect, however modified the tarsi might be, or however strange its contour§. On the same principle, its pentamerous character excludes it from entering the lines of the *Heteromera*, or any other of the great sections.

This is my reason for maintaining that *Hypocephalus* cannot be admitted amongst the *Longicornes*: it must find a place amongst the *Pentamera*. It may be affirmed that the *Tetramera* are pentamerous,—this I cannot admit; the portion considered as a 4th or extra joint, even when articulated, is not the analogue of the 4th joint in the *Pentamera*; it is

* Consult Latreille's Genera Crustaceorum et Insectorum, and that admirable volume, the Considérations Générales.

† Vide Curtis's Brit. Ent. *Homalota*, pl. 514; *Falagria*, pl. 462; *Bledius*, pl. 143.

‡ See the dissections in the Brit. Ent. of *Emus hirtus*, pl. 534, and of 17 other genera of the same family, all of which are pentamerous; and it is deserving of remark, that generally when the number of joints is reduced, they fail in the anterior feet: vide *Phytosus*, pl. 718.

§ Were it not for the number of the palpi, who could imagine that *Mormolyce* and *Omophron* were types of the same family—and that *Carabidæ*?

merely a head or fulcrum at the base of the terminal joint, which is rendered necessary from the 3rd joint being bilobed and cushioned beneath; but as a general rule I consider the bilobed joint to be the penultimate, not the antepenultimate joint, throughout the *Coleoptera*, especially where there is only one bilobed joint*; and when a joint is either added or withdrawn, the change takes place at the *base* of the tarsus†. The *Heteromera*, I think, substantiate this position, for in the four anterior feet, it is the 4th joint which is bilobed; but in the hinder pair it is the 3rd joint which is thus formed, in those species which are furnished with bilobed joints. Even in the few exceptions, if they be admitted as such, we find *more* than one bilobed joint in the foot, or where it is the antepenultimate, which it very rarely is, which is altered in structure, it is not bilobed, but cup-shaped or sloped off obliquely; moreover the false joint in the *Longicornes* is not cushioned beneath like the 3 preceding joints, which shows it is merely the base of the 4th or terminal joint.

Neither do I insist that *Hypocephalus* is a *Lamellicorn*, although I feel a conviction that it is not a *Longicorn*. All my claims for it are based on its being truly a Pentamerous beetle, which draws it nearer to the *Lucanidæ* than it can possibly be attracted to the *Cerambycidæ*, by any less important character. If indeed subsequent discoveries should furnish types to unite the *Lucanidæ* and the *Prionidæ*, *Hypocephalus* may possibly assist in such a union, and I am not sure that it would not be more in accordance with nature, to change the position of the *Heteromera* in a linear arrangement, and attach them to the *Trimera*, with which they have a considerable resemblance. For the *Heteromera* whilst partaking the characters of numberless families, cannot be associated with any of them.

In changing the position of the primary divisions, we should not abandon the philosophic and admirable systems of Latreille; and if we suffer ourselves to be seduced by analogies to wander from well-established systems, without sufficient reasons, we shall have eventually to retrace our steps to free science from the difficulties and confusion in which it has been involved. It is only necessary to review the *Heteromera*, to see how dangerous it would be to lose sight of the tarsal system, for in that extraordinary Section, which seems so distinct from the rest of the *Coleoptera*, one finds the types of form of almost every family of beetles, from *Carabus* to *Coccinella*‡; and I am ashamed to confess that when I collected materials for my "Guide to an Arrangement of British Insects," I was so captivated by analogies, which was the prevailing taste of the times,

* Vide Curtis's Brit. Ent. Genus *Drypta*, pl. 454; *Demetrias*, pl. 119; *Melandrya*, pl. 155; *Lagria*, pl. 598. Also all the Genera of *Curculionidæ* and *Cerambycidæ*; the only exceptions are in the *Trimera* and perhaps *Xylophilus*.

† Additional joints seem to be added at the base of the Tarsi in the *Hydrophilidæ*. Vide Curt. Brit. Ent. *Elophorus*, pl. 466; *Enicocerus*, pl. 291; *Ochthebius*, pl. 250, and *Hydrophilus*, pl. 159.

‡ Thus the *Carabidæ* are represented by *Adelium* and *Akis*; *Scarites* by *Scaurus*; *Harpalus* by *Pedinus* and *Pandarus*; *Silpha* by *Asida*; *Peltis* by *Pterohelæus* or *Cilibe*, Latr.; *Trox* by *Bolitophagus*; *Melasis* and *Agrylus* by *Dircæa* and *Serropalpus*; *Telephorus* by *Nothus*; *Cleridæ* by *Lagria*; *Brachycerus* by *Moluris* and *Sepidium*; *Callidium* by *Pytho*; *Timarcha* by *Gnaptor*; *Cassidæ* by *Cossyphus*; *Coccinella* by *Nilio*; *Erotylus* by *Campsia*, &c. It is twenty years since I first stated that the Coleoptera were composed of 4 distinct Types (it ought to have been 5 lines of form. Vide Brit. Ent. fol. 498), one of which was the *Heteromera*, which seems to be a group complete in itself, and although reflecting all the other Families, being anatomically distinct from them all.

that I was led to make some changes which I shall correct on the first opportunity. Indeed if we were to reject the form of the feet in the *Coleoptera*, disregarding the number of the joints, the *Heteromera* might be distributed throughout the entire mass.

I must not, however, be misunderstood regarding the value of the structure of the mouth in the formation of systems, for although it may be subject to great modifications, and depart from the typical forms, like the changes in the tarsi, such anomalies are perhaps confined to the minuter members of a family, and a comparison of the trophi is unquestionably of the greatest importance in arriving at the true affinities of insects. As our materials multiply our knowledge advances, and changes become necessary and unavoidable, but let them be made on substantial grounds, not losing sight of the first principles of true affinity.

I trust that those from whom I differ in opinion will be assured, that it is from no love of opposition that I have ventured upon this difficult subject, but with the sole desire of arriving at the truth, and to assist in fixing our Systems on some firm basis, generally understood, and universally to be adopted, so that we may no longer be tossed to and fro, as we are at present; every new work, unscrupulously changing, sometimes entirely reversing or disregarding, the labours of the most profound and learned men of science, that have adorned the pages of Natural History.

EXPLANATION OF THE PLATE.

Tab. XXV.

Fig. 1. exhibits the under side of *Hypocephalus armatus*, mas? a little larger than Mr. Turner's specimen; *a.* the *antennæ*; *m.* the *mandibles*; *p.* the *palpi*, the central pair being the *labial*, inserted at the margin of the trilobed *mentum*. Between the base of the head and the antepectus is shown the large membranous triangular *cavity*, enclosed on the sides by a series of broad teeth (*s*). At the base are inserted the 1st pair of legs, with short, slightly dilated tarsi; a lobe passing between the coxæ, dilated at the apex, keeled down the middle (*a. p*). The ample postpectus follows (*p. p*), near the base of which the 2nd pair of legs is inserted, with much longer tarsi, and at the hinder margin the 3rd pair of legs, with enormous thighs, curved tibiæ, and perfect specimens exhibit 5-jointed tarsi similar to the 2nd pair, but the basal joint is shorter. Fig. *b.* is the small attenuated abdomen.

Fig. 2. Upper side of head, showing the spreading lobes at the base (*b*); *a.* basal joint of antenna; *l.* lateral lobes of the head; *m.* the mandibles; *e.* the eyes.

Fig. 3. The insect in profile; *a.* the antenna; *l.* lateral lobes of the head; *m.* the mandibles; *p.* the palpi; *e.* the eye; *s.* the serrated or toothed margin of the antepectus.

Fig. 4. Antenna magnified.

Fig. 4*. The trilobed broad mentum; *p.* the triarticulate palpus.

Fig. 5. Four basal joints of the anterior tarsi magnified.

To illustrate this subject as far as I am able, I have added figures of the trophi, &c. of *Cyrtognathus rostratus*, Fabr.

Fig. 6. Upper side of head; *a.* basal joint of antenna; *m.* mandibles; *e.* eyes.

Fig. 7. Upper side of another specimen, with the thorax, base of elytra and scutellum. The eyes more approximating.

Fig. 8. Head and thorax in profile; *a.* the antenna; *m.* the mandibles; *e.* the eye; *t.* the thorax; *s.* the pectoral spine.

Fig. 9. Labrum.

Fig. 10. Mandible.

Fig. 11. Maxilla with internal lobe; *p.* the palpus, long, hatchet-shaped, 2nd joint the longest.

Fig. 12. Mentum; *l.* labium, formed of 2 lanceolate, very spreading and pilose lobes; *p.* palpus, triarticulate, hatchet-shaped, 2nd joint the longest.

Fig. 13. Anterior tarsus, with subtrigonate, sublunate and bilobed joints and a false or minute joint forming the base of the 4th; *t.* apex of tibia, with the spurs.

March 1854, Belitha Villas, Barnsbury Park.

J. Curtis ad nat. pinxt 1854.

Fred[k] Smith. Sculp.

XXVII. *On the Osteological relations observable among a few Species of the Bovine Family.* By WALTER ADAM, *M.D.* *Communicated by* ROBERT BROWN, *Esq., V.P.L.S.*

Read June 6, 1854.

IN a communication formerly submitted to the Linnean Society*, an attempt was made to trace throughout one large animal the identities and variations of osteological dimension characteristic of a species. The animal selected for that inquiry was the Camel of Bactria.

It is now intended, by an osteological comparison of some species in a cognate group of animals, to exemplify the more striking resemblances and deviations in form which are exhibited among the components of a zoological family. The indulgence of access to the British Museum has enabled the writer to examine at leisure nine osteological specimens contained there, of the Mammalian family of Bovines; three pairs, male and female:—the *Bos Bantiger* of Java, the *Bibos Gaurus* of Nepal, and the *Bison* of North America; along with three separate males,—the *Aurochs* (*Bison*) of Lithuania, the *Caffre Buffalo* of the Cape of Good Hope, and the *Short-horned Buffalo* of the Gambia, the last a young animal. The Bovines, equally with the Camel, seemed deserving of study, on account of their value to Man.

As a standard of measurement within the animal itself, the basilar length of the cranium was found to be most eligible in the Camel; the same dimension, similarly divided into 72 parts, has been continued in the Bovines. Though no single dimension can be assumed to be invariable, the basilar length of the cranium, notwithstanding its rostral termination in the intermaxillaries, will admit of preference in many other animals.

The breadths of the head in the Camel occupy three sets of distances from the mesial plane, ending with the greatest breadth—the orbital. Subsequent to those three dimensions of breadth there are four cranial lengths, beginning with the shortest—the palatal. Thus placed in order, the seven dimensions of the head in the Camel are by six equal decrements successively reduced from the greatest length. Bovine species being numerous, with a corresponding scale of diversity, indications of a fixed normal type could not in Bovines, as a family, be so decided as in the almost solitary Camel. Bovine osteological dimensions will be seen to vary not a little. From size of parts—not always greater in the male—the male and the female bones might even be thought to belong to animals quite distinct. Still the cranial lengths of the Bovines, without such regular progression as in the Camel, show a degree of similarity. In all, the length of the head approaches, in the Gour it attains, the cranial extreme of the Camel. The very different character of

* Linnean Transactions, vol. xvi. p. 525.

profile in the Camel is owing to the backward position of the nostrils. In the Gour the fulness of the inion brings the corono-nasal length almost to an equality with the basilar; so that the lengths of the cranium, beginning with the coronal, which in the Camel are 5 . 7 . 6, may in the Gour be stated to be 6 . 7 . 6. In general, among the other Bovines, especially the males, the basilar length of the cranium, as in the Camel, is intermediate to the elongation of the muzzle and the recedence of the nasal bones; the palatal length also reaches nearly two-thirds of the basilar length.

Continuing the profile: Bovines have no prevailing height of cranium. In the vaulted crania of the Aurochs and the North American Bison the inion is even lower than the nasal bones are over the palate. The inial elevation of the other species may be stated to be one-third more than the palatal. Compared with the lengths of the cranium, the tendency of the palatal height in Bovines is to be one-third of the basilar length. While the vaulted crania, as has been already noticed, sink iniad, the crania of Bovines, which are flattened over the palate, rise to an inial elevation of one half the basilar length. In the male Bantiger the inial height is half the corono-nasal length.

The greatest similarity of wideness in Bovine crania seems to be at the zygomatic arches, where the span of the cranium is exactly, or very nearly, half the basilar length. The muzzles also have a strong resemblance in breadth, that dimension being in all of them more than one-sixth of the basilar length. The broadest muzzle, that of the Cape Buffalo, is exactly a fourth of the basilar length; thus in identity with the cerebral transverse of the cranium. The Aurochs is most conspicuous for wideness of cranium. Next to the Aurochs are the North American Bisons, male and female. In these two species the greater breadth seems to compensate for the smaller height. While in the other Bovines the tendency is to an orbital breadth half the basilar length, the orbits of the Aurochs reach laterally beyond two-thirds of the basilar length, and their expansion is not much less in the North American Bisons.

The horns even show a determinate correspondence with the rest of the osteological structure. The capacious circuit that surmounts the head of the Gour, spreads out, in the fully-developed male, to twice the basilar length of the cranium.

The mesial extent of the Bovine vertebræ, from the occipital condyles to the root of the tail, closely approaches four times the cranial basilar length. It is accurately so in the Aurochs, the North American Bisons, and the female Bantiger. Of all the nine Bovines, the Aurochs and the North American Bisons have the greatest extension of the dorsal vertebræ, as there is of the cervicals in the female Bantiger. The vertebral growth of the under-aged Gambian Buffalo had been with the sacrals, lumbars and dorsals, in the progression 2 . 4 . 8.

Of Bovine ribs, the longest fully attains, or somewhat exceeds, the extreme cranial length. In like manner, the first rib corresponds with the palatal length, slightly exceeding it in those robust species, the Aurochs and the Cape Buffalo.

In no Bovine was there found a perfect identity of dimension between the scapula and the pelvis, except in the female of the North American Bison. The Aurochs and the North American Bisons, both male and female, have the longest scapulæ. The scapulæ,

in their length, seem to be referable more to the basilar than to the extreme of the cranium. On the other hand, the length of the pelvic bones does correspond with the cranial extreme.

In its transverse dimensions the enclosure of the pelvic cavity has no marked identity with the transverses of the cranium. The ischial transverse has some relation to the coronal, or to the extreme, lengths of the head. At the same time, the ischial transverse dimension is very nearly the same as the acetabular, the slight excess of the ischial over the acetabular in the males being reversed in the females. In the young Gambian Buffalo the acetabular development had been more rapid than the ischial.

There is a considerable diversity in length of limb among Bovines, as much in regard to the atlantal limbs compared with the sacral, as to the separate bones of the limbs compared with each other. Except in the male Bantiger and the Gambian Buffalo, the humerus is in a small degree shorter than the radius; while there is more excess of length in the femur over the tibia. The male and the female Bantiger show a difference almost beyond what is specific. In Bovines generally the atlantal extremities are curtailed of the proportion of the longer sacral bones by from a third to a half of the basilar length of the cranium.

	Aurochs.	*Bos Bantiger.*		*Bibos Gaurus.*		*American Bison.*		*Bubalus Caffer.*	*Bubalus Brachyceros.*
		Male.	Female.	Male.	Female.	Male.	Female.		
Actual basilar length of cranium, in inches	18·55	17·80	17·35	19·80	17·90	18·90	17·75	18·60	15·80
Corono-nasal length of cranium, in proportional parts*	65	65	61	71	70	65	62	65	63
Extreme length of cranium	80	82	78	83	84	79	78	79 to occipital cond.	76
Intermaxillaries to inial of palate	44	45	abest	47	46	44	45	45	44
Intermaxillaries to basilar of spinal foramen	72	72	72	72	72	72	72	72	72
Height from inial of palate	26	25	22	24	25	28	24	24	22
Height from basilar of spinal foramen	25	32	36	38	36	25	23	34	30
Intermaxillary transverse	14	13	13	15	14	14	13	18	13
Orbital transverse	50	35	31	40	36	46	41	38	32
Zygomatic transverse	36	33	32	37	34	35	32	36	34
Auditory transverse	34	32	30	35	32	34	30	32	30
Temporal transverse	38	31	26	36	33	40	33	37	no sinus
Cornual transverse (between horns and occiput)	98	114	39	144 horns	84	88 horns 84 tips of corn. bones	78 tips of corn. bones	130 ext. bdth. of horns	69 horns
Cerebral transverse	21	18	18	17	18	21	19	18	19

* The basilar length of the cranium being taken as 72 parts, all the following measurements are in proportional parts.

	Aurochs.	*Bos Bantiger.* Male.	*Bos Bantiger.* Female.	*Bibos Gaurus.* Male.	*Bibos Gaurus.* Female.	*American Bison.* Male.	*American Bison.* Female.	*Bubalus Caffer.*	*Bubalus Brachyceros.*
Vertebræ :—									
Atlas, length, dorsad........	18	9	10	8	9	9	7	10	8
„ transversely..........	32	36	25	32	27	29	24	36	25
Dentata, length, sternad	19	15	16	17	15	13	15	16	11 without articulation
„ transversely, rostrad	17	17	16	18	17	16	17	17 29 caudad	15
„ height, caudad	26	23	21	26	23	24	20	26	19
Cervicals, mesial extent, sternad..................	69	71	80	67	70	67 so 7th cartilage off	70	70	56
Dorsals	128 Fourteen	114 Thirteen	112	114 Thirteen	114	133 Fourteen at articular centres	134	121 Thirteen	96 Thirteen
Lumbars	52 Five	58 Six	58	59 Six	59	53 Five	51	60 Six	48 Six
Sacrals	39 Five	27 Four	38	34 Four	40 Five	34 Five	36	27 Four	23 Four
	288	270	288	274	283	287	291	278	223
Greatest sterno-dorsal of dorsals.................	78 2nd	53 2nd	50 4th	63 3rd	57 4th	75 1st & 2nd	64 1st & 2nd	61 3rd	40 2nd, 3rd & 4th
Greatest transverse of lumbars	57 3rd	62 4th	49 5th	50 5th	50 5th	51 4th	51 4th	56 6th	40 4th
Length of first rib..........	52	45	48	47	50	42	45	51	38
Length of longest rib	82 9th	82 9th	80 9th	86 8th, 9th & 10th	82 8th, 9th & 10th	88 9th & 10th	85 9th & 10th	84	76 9th & 10th
Breadth of broadest rib	..	9 7th	9 7th	8 8th	8 8th	5 7th	6 7th	14	9 7th & 8th
Scapula, greatest length along ridge	84 with cartilage	62	57	76	70	76	72	65	57
„ greatest expanse, dorsad	45	38	32	41	37	35	36	39	31
„ smallest breadth toward glenoid	11	10	8	11	10	10	10	11	9
Pelvic bones, rostro-caudal extent of each .. .	89	78	79	82	82 76 broken	73	72	79	67
„ mesio-lateral expanse of ditto	40	44	36 so	39	36	33	35	41	36
„ compression toward acetabulum......	8	8	9	10	8	7	7	9	7
Lumbar transverse of whole pelvis..................	71	81	69	67	68	66	68	83	67
Acetabular................	40	41	42	38	41	39	41	42	39
Ischial	44	42	39	39	39	38	37	39	29
Humerus, extreme length....	61	51	55	60	56	55	52	54	50
Ulna „ „	72	59	63	74	66	65	61	66	64
Femur „ „	72	68	70	73	69	63	60	64	61
Tibia „ „	69	65	65	68	65	62	60	62	62
	274	243	253	275	256	245	233	246	237

	Aurochs.	*Bos Bantiger.*		*Bibos Gaurus.*		*American Bison.*		*Bubalus Caffer.*	*Bubalus Brachyceros.*
		Male.	Female.	Male.	Female.	Male.	Female.		
Humerus, articular length ..	53	42	48	54	50	49	48	47	44
Radius ,, ,, ...	51	45	48	52	49	48 mesiad	47	45	48
Metacarpus ,, ,, ...	29	27	38 so	38	37	29	32 so	28	32
	133	114	134	144	136	126	127	120	124
Femur ,, ,, ...	67	64	65	68	65	62	58	62	57
Tibia ,, ,, ...	65	56	55	59	58	55	53	56	56
Metatarsus ,, ,, ...	36	40	42	41	41	36	39	33	37
	168	160	162	168	164	153	150	151	150
Humerus, proximal transverse	14	16	17	20	18	17	17	19	15
Radius ,, ,,	15	14	14	15	15	14	14	16	14
Metacarpus ,, ,,	13	11	10	11	10	11	11	12	11
Femur ,, ,,	22	22	21	23	22	22	20	24	20
Tibia ,, ,,	18	18	18	21	19	18	17	19	17
Metatarsus ,, ,,	9	8	9	9	9	9	8	10	9
Humerus, smallest transverse..	7	6	6	9	9	7	6	8	6
Cubitus ,, ,,	8	7	7	9	8	8	7	8	7
Metacarpus ,, ,,	7	6	5	7	5	7	6	7	6
Femur ,, ,,	7	6	7	8	6	7	6	7	7
Tibia ,, ,,	8	7	7	9	7	7	6	7	7
Metatarsus ,, ,,	7	5	5	6	5	5	4	6	5
Humerus, distal transverse ..	14	14	13	14	13	14	14	14	13
Cubitus ,, ,, ..	14	14	11	13	13	14	13	14	13
Metacarpus ,, ,, ..	10	12	9	10	10	11	11	12	11
Femur ,, ,, ..	18	17	17	20	18	16	16	19	17
Tibia ,, ,, ..	9	11	10	12	11	11	11	12	11
Metatarsus ,, ,, ..	9	11	9	10	9	10	10	10	10

N.B. Dr. Adam's Paper was accompanied by a series of Tables, in which the more important Dimensions of the Bactrian Camel, as given in the sixteenth volume of the Linnean Transactions, and those of the nine Bovine Skeletons, as given above, are represented by proportional lines instead of figures. These Tables are deposited in the Archives of the Society.—Secr.

THE

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OF

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PART THE FOURTH.

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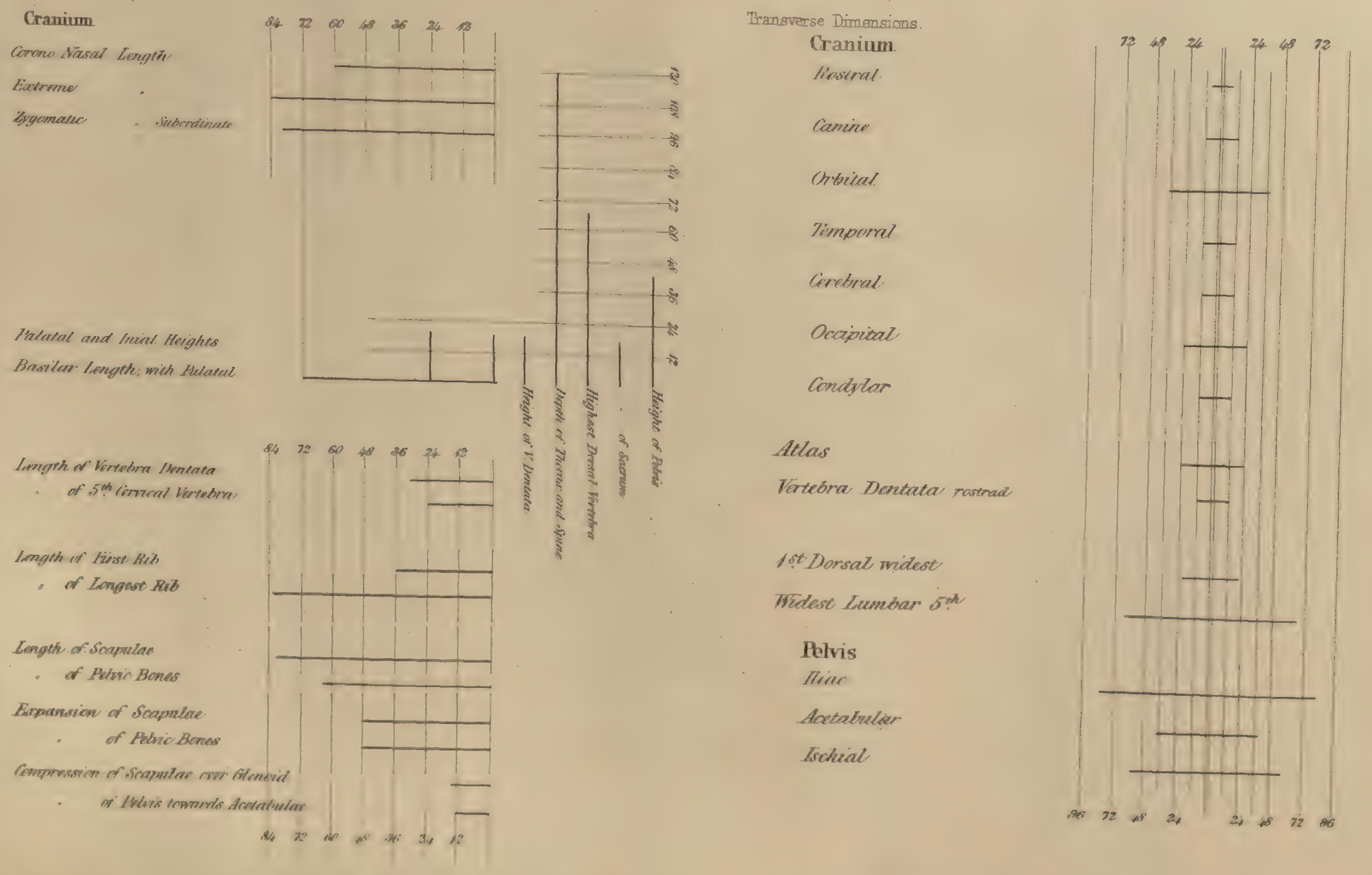
LEADING OSTEOLOGICAL DIMENSIONS OF THE CRANIUM AND TRUNK IN THE BACTRIAN CAMEL.



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XXVIII. *Observations on the Structure of the Seed and Peculiar Form of the Embryo in the* Clusiaceæ. *By* JOHN MIERS, *Esq., F.R.S., F.L.S. &c.*

Read June 20 and November 21, 1854.

THE object of this paper is to present to the notice of the Linnean Society some remarks upon the seed of the *Clusiaceæ*, and to call the attention of botanists more especially to the structure of its embryo, the nature of which has been hitherto quite misunderstood. During my residence in Brazil, I made several observations upon the plants of this family: the many novel facts thus collected have since induced me to extend this inquiry, with a view of determining the true affinities and limits of the Order, and of establishing the characters of its several genera, concerning which our present data are greatly confused and imperfect. The evidence upon these more general points will, however, be reserved for a future occasion; my attention, as a matter of primary importance, being first confined to a consideration of the seminal structure of the family.

The earliest description of these features I find in Jussieu's 'Genera Plantarum,' p. 255, published in 1789, where, in his ordinal character of the *Guttiferæ*, he simply states that its embryo is erect, without albumen, and with hard corky cotyledons (lobis suberoso-callosis).

The next mention is in 1791, by Gærtner, who in his justly celebrated work 'De Fructibus,' &c., plate 105, figures, with his usual fidelity, his analysis of three species of *Garcinia*; these he describes (vol. ii. p. 105) as having a coriaceous testa, a thin integument, and a fleshy solid nucleus, which exhibits in its axis an apparently different development of a terete, sometimes compressed, lanceolate form, the whole nucleus constituting a compact inseparable mass: from these facts, contrary to the opinion of Jussieu, he infers that the great body of the nucleus is a large albumen, and that the axile portion is a pseudo-mono-cotyledonous embryo, closely united together in one solid body.

Richard in 1811, in his excellent memoir on Endorhizal embryos *, in order to mark the difference between the embryonal structure of the Monocotyledones, and certain peculiar macropodal forms observed in the seeds of some dicotyledonous plants, described and figured the structure of the embryos of *Pekea* (*Caryocar*) *tuberculosa* and *Clusia palmicida*. The former has been copied in every botanical work published since that time, in order to serve as an example of that peculiar development, but the latter has never been alluded to, or mentioned, in any such work, that I can find; indeed the fact appears to have escaped the recollection of every botanist who has written upon Guttiferous plants, except Jussieu, although it would have been important to have borne that circumstance in remembrance. Richard there correctly describes the seed of *Clusia* as being enveloped in pulp; one extremity of its brittle testa is pierced with an aperture, beneath which the nucleus exhibits a small protuberance cleft in two, which he states to be two minute cotyledons, the principal mass of the embryo being an enormous radicle; he points out the existence of an inner integument, one end of which is attached to

* Ann. du Mus. xvii. 456. tab. 9 & 10.

the aperture in the extremity of the testa, the whole nucleus forming, in his own peculiar technology, "an epispermic antitropal embryo." There is, however, one essential error in this otherwise correct description; like other botanists, he has mistaken the base for the apex of the seed.

Jussieu, in 1813, in a memoir upon the characters of the *Hypericinæ* and *Guttiferæ*, drawn from the structure of their seeds*, observes, that if the remarkable fact above recorded by so accurate an observer as Richard, be exact, *Clusia* cannot belong to *Guttiferæ*, but must constitute the type of a distinct family nearer to the *Marcgraaviaceæ*.

Choisy, in 1822, in a memoir upon the family of the *Guttiferæ*†, ascribes in its ordinal character features altogether different from those of Jussieu, and equally opposed to the description of Gærtner. He states that the seeds are without albumen, that the embryo is erect, and that the cotyledons are large, fleshy, either separable or combined in one mass. In *Garcinia*, he says, the seeds are arillate, and the cotyledons thick and conjoined; but in *Clusia* he declares that these presumed cotyledons are separable, a feature that no succeeding botanist has verified. He alludes in no way to the very different structure recorded by Richard, of the seed in *Clusia*, although, when he stated the separability of the cotyledons in that genus, this idea may probably have been derived from some indistinct recollection of the analysis of that eminent carpologist.

The description of the *Guttiferæ* in DeCandolle's celebrated 'Prodromus' (1824) is confessed to be a mere recapitulation of the above-mentioned memoir, and consequently the same characters are there repeated upon the authority of Choisy.

Cambessèdes, in a very able essay upon this Natural Order, and on its relation to the *Ternstrœmiaceæ*, published in 1828 ‡, affirms that throughout the family of the *Guttiferæ* "l'embryon est droit, les cotyledons sont grands, épais, très entiers, soudés ensembles; la radicule est très petite, en forme de mamelon; sa direction, relativement au point d'attache de la graine, mérite la plus grande attention, et démontre jusqu'à l'évidence, que dans les familles les plus naturelles, les caractères, considérées dans la plupart des cas comme de la première valeur, peuvent varier dans les genres d'ailleurs extrêmement voisins. Dans le *Clusia Criuva*, dont je possède des graines dans un état parfait de maturité, la radicule est tournée vers l'extrémité de la graine la plus éloignée du point d'attache." I shall presently demonstrate that this statement is founded on error, and that the inferences above drawn are illusory. In that memoir the embryos of *Clusia* and *Calophyllum* are described as being erect, inverted, the small mammæform point, which he calls the radicle, as being at the apex or opposite extremity to the basal hilum of attachment; while in those of *Mammea* and *Mesua*, the radicle is said to be small, and pointing in a contrary direction, that is to say, to the basal point of attachment. He therefore erroneously concludes, that in this family the embryo is either homotropal or antitropal, or in other words, that the radicle is sometimes directed to that point of the seed next the hilum, at others, towards the opposite extremity. It is, however, fair to mention that he had not confidence in the correctness of these observations, and stated his doubts on this point, for the guidance of future botanists.

* Ann. du Mus. xx. 463. † Mém. Soc. Phys. de Genève, tom. i. ‡ Mém. du Mus. xvi. 369.

In the following year M. Cambessèdes minutely described the several Guttiferous plants collected by M. Aug. St. Hilaire, in his journeys through Brazil (Flor. Bras. Merid. i. 314 *et seq.*), and there, in his character of *Clusia Criuva*, he thus defines its seminal features: "raphe ab hilo ad basin seminis ducta parùm elevata; radiculâ brevissimâ, mammæformi, basin seminis hilo contrariam spectante, cotyledonibus coalitis apicem seminis hilo proximum spectantibus." Little dependence, however, can be placed upon this ample and precise definition, especially in regard to the terms *base* and *apex*, because, as I shall have occasion to show, in the figures 8, 9 and 10 of plate 65 of the work referred to, the seed is placed in a position diametrically opposite to that in which it is attached to the placenta, as the point he there assumes to be the radicle is said to be *inferior*, and the stipitate or basal support is there represented as an arillus that covers the *apex* of the seed. It is necessary to bear these circumstances in remembrance, as there is here an evident misconception of the whole structure.

Prof. Kunth, in his details of the several Guttiferous plants collected in the Voyage of Humboldt and Bonpland, throws no light whatever on this portion of the subject.

Doctor Von Martius, in his admirable work (Nov. Gen. et Spec. Pl. Bras.), offers no account, either in his generic or specific descriptions, of the several Guttiferous plants there enumerated, as far as regards the nature of the seed; but he gives ample details of a plant resembling his *Clusia insignis*, and named by him *Platonia insignis*, figuring at the same time the analysis of its fruit and seed. The nucleus enclosed within the testa is there described to consist of a large mass of fleshy albumen, containing numerous oil-cells, and enclosing in its centre a long terete or club-shaped embryo, with a superior radicle, the whole consolidated into one integral inseparable mass. As this form of embryo, and the presence of copious albumen, were facts opposed to the generally received conclusion of botanists, in regard to the structure of the seed in *Clusiaceæ*, he suggested the propriety of placing his new genus *Platonia* in a distinct family, which he proposed to call *Canellaceæ*, thus associating it with the little-known *Canella alba*, a plant greatly differing from it in habit and floral structure, and of which we possess an imperfect knowledge, especially of its carpological features.

Endlicher, in his 'Genera Plantarum,' gives the characters of the Order and of each genus of the *Clusiaceæ*, in accordance with the views of Cambessèdes, and arranges *Platonia*, after Von Martius, in the *Canellaceæ*, as a suborder of the *Guttiferæ*.

Pöppig, in his 'Nova Genera et Species,' although he details the characters of several genera and species of Guttiferous plants from Peru and Northern Brazil, and figures some of them, does not enter into any description of the structure of the seed.

Prof. Lindley, in his 'Vegetable Kingdom,' where he gives an outline of the ordinal characters of the *Clusiaceæ*, adopts the views of Cambessèdes in regard to the nature of the seed, notwithstanding that he admits *Platonia* as a member of the family.

Prof. Miquel, giving in 1844 a detailed account of a species of *Arrudea* (Linn. xviii. 232), follows the example of Cambessèdes in misconceiving the structure of the seed, for he describes the embryo as having fleshy plano-convex cotyledons, and a very short radicle.

Lastly, M. Choisy, in a more recent memoir (1850) * on the *Guttiferæ* of India, and

* Mém. Soc. Phys. de Genève, tom. xii. p. 381.

some little-known American plants of this Order, gives many interesting observations on the organography, affinities and subdivisions of the family, as a prelude to a review of the various genera and differential characters existing between them. It is, however, singular, that in a memoir of such length, where he discusses fully the general structure of the Order, he does not make the smallest allusion to the important question of the nature of the seed, concerning which so many uncertainties and incongruities are known to exist: this is the more remarkable, because in the interval of nearly thirty years since the appearance of his previous memoir, the facts subsequently published are at variance with his former views on this subject.

As the results of my inquiries are widely different from the conclusions of Cambessèdes, which have been almost universally adopted by botanists, it will be better to select from my several observations the analysis of the fruit of a species closely allied to the *Clusia Criuva*, Camb., upon the examination of which that able botanist principally relied, in the construction both of his ordinal and generic characters. Here the fruit is an oval drupaceous-looking capsule, 10 lines long and 8 lines in diameter; it is 5-celled, with 5 very thick fleshy valves, which break away by their margins from the edges of the partitions, and become rotately expanded, leaving a large erect 5-winged column, in the angles of which the seeds are fixed. Each cell contains about 12 seeds, enveloped in a thick mucilage, and these are attached horizontally by one extremity to the placentary column, in two longitudinal rows. The seed is of an oval form, about $\frac{1}{8}$th of an inch in length, and is slightly gibbous on the upper or dorsal side, the lower or ventral face presenting a prominent keel, extending from the base to a swollen point near the apex. The external tunic, at first thick and fleshy, and of an orange colour, forms when dried a thinner tough skin, and when it is scraped off, the keel seen on its ventral face is found to cover a bundle of fibres in the form of a raphe, one end of which proceeds from the stipitate base of the covering and the point of its attachment to the placenta, as well as to the body which it encloses, the other end terminating near the summit by a sudden reflexion, where it enters an aperture through the crustaceous integument of the seed: this is a hard, brittle shell, striately punctate, of an oval form, and a little flattened at the base, where, somewhat excentrically, is seen a very small point or cicatrix at the origin of the raphe-like cord: on the contrary or apical extremity, always somewhat on the ventral side, and around the opening through which the raphe-like cord penetrates the shell, is observed a prominent ring, radiately striated, forming a hollow cup: this outer shell is smooth within, and lined with a very thin free integument, that is contracted near the summit by a narrow neck of a darkish colour, by which it is suspended and connected with the extremity of the raphe-like cord: the solid nucleus filling the cavity of this integument is of a pale greenish colour, marked by numerous very distinct, prominent, parallel and longitudinal lines of an orange colour, which do not reach the base, but terminate round a flattened colourless space, like that seen in the outer shell, and in the middle of which a minute shining tubercular point is observed: the apex of the nucleus is distinguished by a short hemispherical nipple-shaped protuberance of a smaller diameter, which is divided to its base by a distinct transverse cleft into two equal portions, the bottom of this commissure on the ventral side corresponding with the dark-coloured

neck of the inner integument, as well as with the somewhat lateral aperture in the outer shell, and the termination of the cord already described; on making a longitudinal section of the nucleus, this cleft is more distinctly seen, and at the bottom of this commissure is observed a small prominent point, and also in the axis extending from this spot to the small tubercular point at the base is seen a continuous line, more or less narrow, somewhat curved, and of a more opake and whiter colour than the body of the nucleus: the principal mass is of a semi-crystalline hue.

This internal thickened line is what Gærtner considered to be the embryo of the seed, and the fleshy surrounding mass to be copious albumen. Choisy, Cambessèdes, and most other botanists, have considered the main body of the nucleus to be two large cotyledons agglutinated into one solid mass, the line of their junction being indicated by the curved line just mentioned, while they held the nipple-shaped protuberance to be the radicle. In the description above given, I have been careful to avoid the use of technical names in designating the several parts, until the whole evidence has been stated; but the inferences I have drawn from these facts, which I will here endeavour to substantiate, are, that the seed is enveloped by an entire arillus, with a raphe extending from the hilum, or basal point of its attachment to the arillus and placenta, to the process or cup-shaped ring surrounding the aperture situated near the geometrical apex of the testa, and through which the nourishing vessels of the raphe pass, to unite with the inner integument: the small cicatrix at the opposite extremity of the testa, near the hilum, must be considered as the micropyle. Most botanists will perhaps call this extremity the *base* of the seed, and correctly so, although others have considered the geometrical apex as the true *base*, because it was once the base of the ovule before it became reversed in its position by its anatropal development: the use of this term, unless accompanied by an explanation of the sense in which it is applied, leads constantly to error and confusion*. The existence of the internal chalaza in the contracted and thickened summit of the inner integument, and its connexion

* Great mystification is often created by the misapplication of the several terms *umbilicus, hilum, apex* or *base* of the seed, which are used in a contrary sense by different botanists; and even Richard, who may be regarded as a leading authority on this point, is not free from similar confusion. St. Hilaire, in his Monograph on the Brazilian *Violaceæ* (Mém. du Mus. xi. 446), accurately describes the structure of the seed in *Viola* to be caruncülate at the point of its placentary attachment, which he calls the "*umbilicus*," and the corresponding point of the *testa*, the "*hilum*," to which the inferior radicle is directed, while the areolar "*chalaza*" is seen at the opposite extremity, or "*apex*." Prof. Kunth, on the contrary (Nov. Gen. et Spec. v. 368), describes the seed in *Viola* as being caruncülate at the *apex* by which it is attached to the placenta, with a *basal* chalaza at the opposite extremity: the embryo is said to be inverted, with its *superior* radicle directed to the *hilum*. Here we observe that two of the highest authorities apply the same terms in a directly opposite sense; the one truly, as regards the point of the placentary attachment of the seed, considering that point as its base, whatever be its position in respect to the axis of the fruit: the other uses the same terms relatively to the direction which the seed may bear in regard to its position with the axis of the pericarp, which in the instance of *Viola*, being suspended from the placenta, gives a reversed attitude to all its several parts: if this loose glossology were admitted, how could we define the base and apex of the seeds, where they sometimes happen to be erect, horizontal, and pendent in the same cell?

Cambessèdes has fallen into an error of a similar nature in reversing the position of the seed in his representation of *Clusia Criuva* (Flor. Bras. pl. 65. figs. 8, 9 & 10), where the stipitate support is miscalled and delineated as an apical arillus, and his radicle (the true cotyledons) are seen at the *base*, instead of the *apex* of the seed.

with the raphe through the *diapyle** or aperture in the testa, constitutes an important feature in this inquiry. The nipple-shaped protuberance in the summit of the nucleus, hitherto taken to be the radicle, appears to me, without the smallest doubt, as was first shown by Richard, to be the two cotyledons of the embryo, which, although small and short, are nevertheless quite distinct, and their relative position is indicated by the direction of the cleft, being placed right and left of the axis, or with their commissure pointed to the raphe: the main body of the nucleus, instead of being the confluent cotyledons, as hitherto supposed, must be a gigantic radicle, in the axis of which is imbedded the caulicle of the embryo, shown in the opake central line previously mentioned, terminated at its base by the shining speck before described, and at its apex by the plumule, which is seen protruding into the space at the bottom of the cotyledonary cleft. The minute external speck, which I consider to be the germinating point of the caulicle, is always more or less prominent, and of a green colour in the living state: this point does not exactly correspond in position with the micropyle of the testa, but is somewhat lateral in respect to it, and nearer the basal origin of the raphe.

Although this axile portion of the radicle is plainly distinguishable in numerous other less prominent cases, it has never been distinctly noticed. In *Pekea* the superiorly exserted portion of this process has been called the caulicle †, a name also given to the large germinating protrusion in the embryo of *Rhizophora*, but inappropriately, because that term is applicable only to the ascending system, or the elongating portion of the plumule above its junction with the cotyledons: all below this point belongs to the descending system, and in order to distinguish it from the main radicular mass, it may be called the *neorhiza*: it is in fact the growing portion of the elementary root, the more external mass of the radicle being inert, or at least serving only the purpose of albumen or of large fleshy cotyledons, in affording nutriment to the germinating parts of the embryo ‡.

* This word is proposed to denominate the distinct aperture often seen pierced through the substance of the osseous testa, and by which the raphe penetrates, to unite with the chalaza of the tegmen or inner integument of the seed, and is used in contradistinction to the *foramen*, a term applied to the orifice of the primine of the ovule, which afterwards becomes the *micropyle* of the seed: this last, in seeds produced from anatropal ovules, is situated at the extremity always opposite to that in which the *diapyle* is placed. In the case of *Clusia* above detailed, the *diapyle* is a very manifest aperture, filled with soft fungous matter; in some other cases it is closed by the osseous deposits of the testa, and is only recognizable as the point where the extremity of the raphe, when it is free, penetrates the testa. This must not be confounded with the *omphalode*, a term applied by Turpin to express the aperture in the centre of the hilum in antitropal seeds through which the nourishing vessels pass to promote the growth of the embryo; nor with the *caruncula*, a name used to express indiscriminately any excrescence or swelling upon the testa, whether about the strophiole, about the hilum, or about the micropyle, where, according to St. Hilaire, it is sometimes observed, as in *Euphorbia*, *Ricinus* and *Polygala*.

† This term (synonymous with the *tigelle* of the French botanists) is vaguely applied by some authors: thus Gaudichaud (Recherches sur l'Organographie, &c. p. 39) defines "la tigelle, ou ce qu'on nomme ordinairement la radicule dans les embryons; cette partie sert à la composition des tiges." By this is evidently meant only that ascending portion of the collar of the embryo, which I have above defined as the true caulicle, and which does not belong to the radicle, although continuous with it.

‡ It may be maintained by some, that Gærtner's view is correct in considering the great body of the radicle as an albumen, and the neorhiza as the radicle, both agglutinated into one mass; but this argument will not hold good,

I have already alluded to the existence of two somewhat different developments of the seed in the *Clusiaceæ*; the foregoing description affords an example of the one which includes all cases (as in the tribe *Clusieæ*) where a number of seeds are formed in each cell of the ovary, and where they are attached in a horizontal position by their base to the axile placenta. The other development occurs in those instances (as in the tribes *Tovomiteæ* and *Garcinieæ*) where only one seed is formed in each cell, and where this is fixed to the axile column in a vertical position by its ventral face. For reasons that will be offered in another place, I propose to exclude the *Moronobeæ* and *Calophylleæ* from the Order. In the first case (the *Clusieæ*), the raphe, enclosed within the fleshy arillus, is seen to extend from the base to the apex of the seed, and is free from the testa; in the second instance the testa is thinner and more membranaceous in texture, and enveloped in an overlapping arillus, which is thicker and more membranaceous in substance; it has a large hilum upon its ventral face; the raphe, less discernible, is imbedded in the substance of the testa, where it spreads into numerous branching nervures, conspicuously extending over its surface: in the *Garcinieæ* we find a similar testa, enveloped in an entire, copious, more or less mucilaginous pulp; tolerably good figures of this development are given by Gærtner in plate 105, illustrating the seeds of *Garcinia*, and in several plates of Dr. Wight's 'Icones.' Were it not for the explanation afforded by the analysis of the *Clusieæ*, the structure of the embryo in the other tribes, *Tovomiteæ* and *Garcinieæ*, would not be so easily understood. During my residence in Brazil, I examined in a living state the fruit and seeds of different species of *Tovomita*, *Commirhœa*, and more especially of a plant which I have called *Lamprophyllum lætum*, the type of a genus very distinct from *Garcinia*, and comprising numerous species of South American and West Indian origin, among them the *Calophyllum Calaba* of Linnæus, and others associated with *Garcinia* and *Calophyllum*, which last genus I consider to be foreign to the Order. The analysis of the seed of *Lamprophyllum* will afford a good example of the second mode of development above referred to. The drupe is here about the size of that of *Calophyllum Calaba*, as figured by Jacquin (Stirp. Amer. tab. 165), and contains generally two, or often by abortion a single seed, about the size of the kernel of a hazel-nut, which is enveloped in a thick mucilaginous pulpy arillus: the testa is thin and brittle, marked by numerous veins branching from the ventral hilum, and it contains a solid nucleus of a firm and somewhat fleshy consistence, exhibiting in the apex a minute prominent nipple of the size of a very small pin's head, seated in a deep hollow depression, a little below the summit towards the ventral face; near the base, somewhat on the dorsal side, is seen another smaller speck, which is green and shining, exactly like that described in the nucleus of the *Clusieæ*. On making a longitudinal section, the main body of the nucleus is seen to be of a pale sulphur colour, studded with numerous small oblong ducts, which, when thus cut, copiously exude a deep yellow viscous juice: a slender terete neorhiza, exactly resembling

because we see in the *Clusieæ* that the neorhiza is traceable only to the nascent point of the plumule, that the cotyledons are wholly exserted from and an extension of the main body, and that many of the striæ or long tubular ducts, which extend from the base to the apex of the mass of the nucleus, are carried without interruption along the outer face of the cotyledons, proving the continuity of the one with the other; for were it of the nature of albumen, it would be in the form of an investiture of the embryo, not a prolongation of it.

that observed in the seeds of the *Clusieæ*, is seen in the centre, somewhat oblique with the axis, one extremity of which terminates in the minute nipple near the apex, and the other in the basal speck before mentioned: this latter spot is without doubt the germinating point of the root, the apical nipple is the plumule, the main body of the nucleus must be the radicle, and the cotyledons at first sight appear to be altogether wanting; but on examining more attentively the minute nipple-shaped process, this is seen formed of four diminutive fleshy imbricated scales, surrounding a central prominent point, which is concealed by the two inner and larger scales; the two outer decussating scales thus separated from each other, are smaller, shorter, and placed right and left of the ventral face, as in the cotyledons of the *Clusieæ*. This structure is so minute, that it requires the aid of a strong lens to distinguish it. It may be said by some, that the two outer scales form part of the plumule, and in such case the embryo would be truly acotyledonous; but it appears to me that they ought to be considered as the real cotyledons, not only from analogy, but because they agree in position with the cotyledons found in the *Clusieæ*, with their commissure directed to the ventral face. I have elsewhere pointed out the analogy of this structure to that of *Caryocar*, and it constitutes a curious physiological fact. The absence of cotyledons has long been recorded in plants of a low order of development, and is known to occur also occasionally in exogenous plants among those which are almost leafless, such as *Cuscuta*, *Vohiria*, &c., whence it has been argued, that the abortion of the cotyledons in the embryo is indicative of the future absence of leaves in the plants produced by the growth of such seeds. In the case of the *Clusiaceæ*, however, where the floral structure is of the highest order of development, belonging frequently to the largest trees of the tropical forests of both hemispheres, with copious foliage, large fleshy leaves, and rich in mucilaginous juices, the absence of cotyledons in the seed, or their reduction to microscopical proportions, offers an anomaly suggestive of many considerations upon the nature of the organs of vegetable reproduction.

This same internal structure of the seed occurs in every instance I have examined, and is confirmed by all the evidence obtainable from recorded authority, so that little doubt can exist that it is constant throughout the Order, with the exception of genera, which, for reasons to be mentioned in another place, I propose to exclude from the family. The evidence here alluded to exists in the drawings of Gærtner, to which I have already referred; in the rough sketch given by Plumier in his 'Pl. Amer.' tab. 257. fig. *g*, *h*, *i*, which shows a similar structure in the seeds of *Rheedia lateriflora*; Dr. Graham also thus describes the seeds of *Hebradendron gambogioides*, "cotyledons thick, cohering in an uniform cellular mass, radicle central, filiform, slightly curved," a structure which, though described in other terms, is substantially the same organization that I have related; Dr. Wight, in his admirable 'Icones,' gives other examples of a similar structure, in plates 118, 192 and 960; and Dr. Roxburgh exhibits the same facts in his 'Coromandel Plants.' These are the only positive details I find upon record, except the analysis of *Calophyllum*, to which I will revert at another time. All accounts therefore confirm the constant presence of that peculiar development in the axis of the solid nucleus of the seeds of the *Clusiaceæ*, which I have characterized as the neorhiza of the embryo; for our decision upon this point will determine the nature of the other parts of the nucleus, to which such

various attributes have been assigned. This determination is fortunately assisted by the drawings of Dr. Roxburgh, whose details, always accurately observed, are copied by Dr. Wight in his 'Icones,' where in pl. 192. fig. 12 & 13, is shown a seed of *Xanthochymus dulcis*, in a state of germination, together with a longitudinal section of the same: here is depicted precisely the same linear process (the neorhiza), which is throwing out a root from the basal speck I have described, while the apical nipple of this same process has simultaneously become extended considerably, carrying upward with it the leaflets of the growing plumule: from the lower part of the neck thus protruded, and beneath the two lower scales which I have designated as the cotyledons, a second rootlet is seen to sprout, tending first horizontally and then downwards. We have here unquestionable proof that the process in question is what I have called *neorhiza*; for were it the embryo imbedded in albumen, as Gærtner affirms, it would not throw out descending shoots at the upper portion as well as the base; nor would the same result follow if it were the radicle, according to the view of Dr. Graham. The fact is certainly fatal to the conclusions of Choisy, Cambessèdes, and other modern botanists, that the great mass of the nucleus consists of two confluent cotyledons, and that the mammæform apex seen in the seed of the *Clusieæ* is its radicle, even if this opinion had not been disproved by the structural appearances which I have already described, and which are still further confirmed by a more minute examination of its internal organization.

On placing a thin transverse slice of a seed of *Lipophyllum* (*Clusia*, Camb.) under the microscope, it will be seen to be of a reticulated texture, and composed of a number of small hexagonal cells filled with yellowish grumous viscid matter, except in the centre, across the line of the neorhiza, where the cells cease to be distinguishable: close to the periphery, and corresponding with the external striæ which I have described (p. 246), a circle of about fifty very conspicuous ducts is observed, each duct having a diameter three times that of the reticulated cells: they are separated from each other by one or two rows of the same kind of cells that fill the main area, the circumference of the nucleus being formed of a very thin epidermis lined with parenchyma. On examining another slice of the same seed, cut in a vertical direction parallel with the axis, a somewhat different appearance is manifested; the cells no longer seem reticulated, but form regular longitudinal channels, interrupted by transverse septa placed at distances nearly equal to their diameter, bearing the semblance of articulated tubes or muriform tissue; they cease to appear along the line I have designated as the neorhiza: the large ducts near the margin are entire and hollow tubes with simply striated surfaces, and are filled with a yellow secretion of a more fluid nature than that of the cells, though still somewhat viscous. The neorhizal portion appears formed of longitudinal and exceedingly minute lines, exhibiting a uniformly striated opake and whitish texture. I have observed, in the seeds of the genus *Quapoya*, a structure exactly similar to that just described, except that in addition to the external row, a few similar longitudinal ducts filled with yellow fluid appear interspersed within the main area. M. Cambessèdes, in his figure of *Clusia Criuva* before referred to, has depicted on the outer surface of the nucleus the same external striæ, but he makes no allusion to the circumstance in the text.

It is requisite to offer some observations upon the nature of the external covering of

the seed, and to determine whether we are right in considering it to be an arillus, as doubts have been suggested on this subject by some eminent botanists. In the *Clusieæ*, this consists of an entire coating, without the smallest fissure; it is fleshy, equal in substance, not very thick, and generally of a reddish or orange colour. In the *Tovomiteæ* (at least I speak from observation in *Tovomita* and *Commirhœa*, and Pöppig relates the same of *Chrysochlamys*), it is slit upon the dorsal face from top to bottom, with its fimbriated edges overlapping each other, so that when opened out, it appears like a flat sheet with the seed attached in its centre. In the *Garcinieæ*, the external coating is much thicker, of a more fluid and mucilaginous substance, generally edible, and quite entire, as in the *Clusieæ*. Notwithstanding the different aspect and texture of this covering in the two last-mentioned tribes, its nature cannot there be questioned, and it is quite fair to conclude that the precisely analogous development in the *Clusieæ* is, in like manner, a true arillus. It is, however, essential to determine this point beyond cavil, because in the *Hypericinæ*, *Marcgraaviaceæ*, and other orders, it has been held to be merely a thickened epidermis of the testa, while in the *Magnoliaceæ* it has been assumed to be the testa itself. In the latter family, where the seeds are generally suspended by long funicular threads, it forms a very conspicuous development, under the appearance of an entire, fleshy, scarlet-coloured covering, precisely similar to that of the *Clusieæ*, and where in like manner within it, on one side, somewhat pressed into its soft substance, is seen proceeding from the basal hilum to the apex a flattened raphe, the upper extremity of which is lost in a fungous spot filling the cavity of a distinct aperture pierced through the osseous shell,—a tunic which by most botanists has been regarded as the *testa*, but which, by some authorities, has been held to be the *inner integument* of the seed, called *tegmen* by Mirbel, and *endopleura* by DeCandolle. Endlicher was the first to suggest this idea, which he expresses in a very ambiguous manner; in his 'Genera Plantarum,' p. 837, he states that the seeds of the *Magnoliaceæ* have, in most cases, an external, fleshy, coloured *integument* covering a crustaceous *testa*, with its *raphe* situated between it and the *testa*, and terminated by a *chalaza* in its summit, but that sometimes there is no *outer integument*, the *raphe* in such case being found between the *testa* and *endopleura*. In this definition, Endlicher evidently designates by the term *chalaza*, the aperture in the summit of the *testa*, which I have called *diapyle*, and such misapplication of the term *chalaza* (a word, strictly speaking, confined to the peculiar thickening of the *tegmen* or *inner integument*, where it is connected with the *raphe* around the point in which all further trace of the continuity of the nourishing vessels ceases) has probably led to the error of considering the true *testa* to be the *tegmen* of the seed. In the diagnoses of the several genera of the Order (at least in the tribe *Magnolieæ*), the first-mentioned character is assigned in detail to each genus in succession; but as the latter very inexact feature (where the *raphe* is found between the *testa* and *inner integument*) is applied to no single genus, it was probably meant to refer to the *Illicieæ**, although this is nowhere explained or described. Dr. Asa Gray, however (in his 'Genera Pl. Un. St.' i. p. 60. pl. 23), adopts and amplifies this suggestion in unequivocal terms; stating that in *Magnolia* the seed is

* On some future occasion I will state my observations upon the seeds of *Drymis*, which present anomalous appearces worthy of notice.

exarillate, and he denominates the scarlet-coloured external tunic the *testa*, which preceding botanists have considered to be the *arillus*, while the hard crustaceous shell, called *testa* even by Endlicher, is designated by him as the *tegmen*. This he infers from the fact of having observed spiral vessels in the placentary attachment of the ovule (*loc. cit.* fig. 7), which he thinks "clearly demonstrates that the baccate exterior integument of the seed is formed of the primine of the ovule, and therefore is not an arillus*." Had this distinguished botanist actually traced the growth of this last-mentioned tunic in its different stages, from the primine of the ovule, he would have established an inexplicable fact, but this he does not appear to have done; simply therefore because the primine is the more exterior tunic of the ovule, and the arillus is the outermost coating of the seed, it does not necessarily follow that the one is the product of the other; and notwithstanding the argument of Dr. Gray, there is little reason to doubt that in *Magnolia* the scarlet envelope is due to a subsequent growth over the primine, as occurs in other numerous well-known cases. I would not, however, now presume to question the validity of an inference standing upon such high authority as that of my valued friend, without being able to offer reasons grounded upon observations made by me many years ago in Brazil, upon living seeds of *Talauma*, a genus closely allied to *Magnolia*. 1st. I found the thick outer tunic to consist of a fleshy or oily matter in distinct granules enclosed within a thin external epidermis, and an inner one of a similar nature; this is the usual texture of *arillus*, not of *testa*. 2nd. The coating called *tegmen* by Dr. Gray, and considered by him as the innermost integument, is in reality the intermediate envelope in *Talauma*; it is black in the living state, with a small basal hilum; a longitudinal furrow runs along its ventral face for the reception of the *raphe*, and a brown fungous scar, through which the *raphe* finds a passage to the interior, fills a hollow cup in the apex, where there exists a distinct aperture (the *diapyle*) for this purpose: this process Dr. Gray, following the example of Endlicher, considers to be the *chalaza*: the crustaceous envelope is thick and osseous in texture, bearing all the characters of a *testa*, and certainly none of those of an innermost integument of the seed. 3rd. The existence of a membranaceous *inner integument* around the albumen, first indicated by Gærtner, within the true *testa*, thickened and discoloured around its summit by a well-marked *chalaza*, where it is attached by a short neck to the fungous process that covers the *diapyle*, and where it unites with the

* St. Hilaire has expressed similar views in regard to *Euphorbiaceæ* (Leçons de Bot. p. 728), founding his notion upon the authority of Schleiden, who, although a very acute observer and a physiological botanist of the highest repute, is not always free from error in his conclusions, and who asserts that the external fleshy coating of the seed of *Euphorbia* is derived from the primine. I have examined a great many seeds of arborescent *Euphorbiaceæ* in Brazil, and have found them generally covered with a coloured fleshy arillus, having a distinct raphe extending from the apical hilum to the basal diapyle of the bony testa, and which cord constantly occurs between the testa and arillus: there always exists a more internal membranaceous integument with its basal chalaza. It is therefore clear in these cases, as in the instances alluded to in the text, that the nourishing vessels proceeding from the placenta through the funiculus to the foot of the primine, will, by the reversion of the ovule, necessarily have become extended with it, and produced along its surface; and it follows that the raphe, thus resulting and afterwards apparent as a free or imbedded cord, will manifest itself always upon the outer face of the testa (the product of the primine), and that whatever coating may posteriorly appear covering the raphe, such must be of subsequent and exterior growth, and therefore an arillus.

raphe, is a development wholly unnoticed by Dr. Gray, by Endlicher, or by DeCandolle; but it is an important feature, because it proves that the bony coating is the *testa*, and not the *tegmen* as has been inferred. 4th. The *raphe* proceeding from the hilum is wholly exterior to and free from the osseous coating, and interior to the outer tunic; and this is the constant position of *raphe*, when it is free, in regard to *arillus* and *testa*,—assuredly not in respect to *testa* and *tegmen*. 5th. As the *raphe* consists of the nourishing vessels originally existing in the funiculus or placentary attachment of the anatropal ovule, it could never have existed between the *primine* and *secundine*, but must have been, as Dr. Gray figures it, wholly exterior to the *primine*, and consequently, as we afterwards find it, outside the *testa*, which is the product of the *primine*; hence as the *raphe* is found in a free state, though partially impressed in its soft substance, within the external tunic, the inference is irresistible, that the latter must be of posterior growth, therefore *arillus*, and in this manner enclosing the *raphe*. 6th. We have thus the evidence complete, of the existence of the usual and distinct envelopes around the nucleus of the seed, viz.:—an *inner integument* with its apical *chalaza*, an intermediate hard *testa* with its corresponding *diapyle*, through which the nourishing vessels of the more exterior *raphe* penetrate, and the whole included within a scarlet-coloured soft *arillus*.

From all these facts we may safely infer, that the envelope, which is unquestionably an *arillus* in the *Garcinieæ* and the *Tovomiteæ*, must be of the same nature in the *Clusieæ*, and that which is *arillus* in the *Clusieæ* must be the same development in the *Magnoliaceæ*: that which is granted in the one cannot be denied in the other. Although it be true that the several envelopes of the seed in different families are not to be recognized alone by their consistency, which may be, contrary to general rule, more or less membranaceous, ligneous, cellular, or composed of oily or resinous granules according to circumstances, yet they may be determined by their relative position in regard to *raphe*, *chalaza*, *diapyle*, *micropyle*, *hilum*, &c., from which their true nature may always be inferred with greater certainty*.

* The want of precaution in attending to the nature of the nourishing vessels proceeding from the placenta and penetrating the different integuments, in order to promote the growth and perfection of the seed, has frequently led to a misconception of its real structure. These vessels present themselves in the shape of a raphe-like cord under three very different aspects:—1st. When the cord, originating in the base of the cell, terminates often at the opposite extremity in the hilum of the contained seed; it is then properly the *funicular cord*, of which the common Cherry affords a very good example: sometimes it is inappreciably short; in other cases, as in *Magnolia*, it forms a very long thread, by which the seed is suspended when it escapes from its cell. 2nd. When these vessels, existing in the form of a thread, either free and exterior to the testa, or partially imbedded in its substance, spring from the point of attachment of the hilum of the testa, and extending along its surface, penetrate its substance at a spot called the diapyle, to unite with the chalaza of the inner integument, which is invariably opposite to the cotyledonary end of the embryo; this is the well-known *raphe*. 3rd. When the vessels passing from the hilum penetrate the inner integument and extend in the shape of a thread beneath its surface, in order to attain the radicular (not the cotyledonary) extremity of the embryo; in this case they constitute the *suspensor*, which has sometimes been mistaken for a raphe; it occurs in *Tropæolum*, where its origin has been well illustrated and described by Dr. Giraud, in a memoir on the development of the embryo in that genus, published in the nineteenth volume of the Society's Transactions. The want of attention to the existence and position of the true raphe has often led to erroneous inferences in regard to the affinities of different genera, and among the *Clusiaceæ* may be cited the instance of *Calophyllum*. Gærtner (De Fruct. i. 200. tab. 43. fig. 1) gives an analysis of its fruit, where overlooking the existence of the raphe, he has mistaken the extra-

Connected with the issue of this question is that of the origin and mode of growth of the arilliform covering of seeds, which by St. Hilaire is considered to be of two kinds; one designated by him the *true arillus*, the other the *false arillus*; the former he defines as an envelope open at its extremity, while the latter entirely covers the seed*. This has been well discussed by Dr. Planchon, in an able memoir on the subject†, where he greatly modifies the views of St. Hilaire, and proposes to give to the false arillus the name of *arillode*. Under this point of view, both kinds of envelope are alike in colour, texture and form, being either gland-like, lobed, laciniated, more or less cupuliform, or entire and wholly concealing the testa; their difference consisting in this, that the arillus, whether abbreviated or entire, always covers the micropyle of the testa, while the arillode constantly exhibits a minute or larger opening in its surface, around the micropyle, which is never covered by it (*loc. cit.* p. 10), and he further points out the mode of distinguishing the one from the other. "Si cette ouverture (le micropyle) est cachée par l'enveloppe, ou si elle doit l'être, dans le cas où celle-ci serait prolongée, on a un véritable arille. Si le micropyle, au contraire, n'est pas recouvert par l'enveloppe, ou ne peut l'être même par cette dernière prolongée, nous aurons un faux arille du même genre que celui de l'*Euonymus*." It will be seen that St. Hilaire points to *Euonymus* as an instance of his true arillus: Dr. Planchon, on the contrary, selects that genus as offering the type of his arillode. He traces the distinction that exists between them from their different sources of origin, attributing the growth of the true arillus over the ovule to a gradual enlargement of the funiculus, and noticing its earliest appearance from a mere swelling of the umbilical cord to its gradual increment and ultimate development; but the arillode he states to be derived from an enlargement of the mouth of the exostome or foramen of the ovule, its margin being reflected and produced over the primine, thus growing upon it in the form of an additional tunic. In either case, whether this accessory coating be of the nature of arillus or arillode, it is clear, if it be entire, that the raphe must necessarily be enclosed within it. The arillus, according to this view, is found in the *Passifloraceæ*, *Dilleniaceæ*, *Anonaceæ*, *Samydaceæ*, *Turneraceæ*, *Bixaceæ*, *Sapindaceæ*, &c., while the arillode is conspicuous in *Celastraceæ*, *Cactaceæ*, *Malvaceæ*, *Büttneriaceæ*, *Euphorbiaceæ*, &c.: in this latter family, however, the peculiar carunculoid swelling around the micropyle (I do not allude to the fungous strophiole) is called arillode, while that integument which I take to be the true arillus in that Order (note, p. 253) is considered by Dr. Planchon to be a mere epidermis of the testa. It would indeed be difficult to discriminate between a thin arillus and a thick epidermis, as both appear to be of the same nature, differing only in their relative thickness. The origin of the arillus is now well established, but

ordinarily thick testa for the endocarp of the putamen, and calls the inner integument its testa. I have observed, however, the existence of this cord springing from the point of attachment of the hilum to the base of the cell of the putamen, and extending along one side to the summit of the cell, where it penetrates the very thick testa, to unite with the inner integument at the cotyledonary end of the embryo. The very peculiar nature of this testa, together with the small inferior radicle, and the existence of two large distinct fleshy cotyledons in the embryo, added to other differences in the structure of the flower, and the peculiar venation of its leaves, all serve to remove this genus from the *Clusiaceæ*, its position being probably in *Lophiriaceæ*, as was long ago suspected by Prof. Lindley.

* St. Hilaire, Pl. Us. no. 43. p. 4.

† "Mémoire sur le développement et les caractères des vrais et faux arilles," &c. Montpellier, 1844.

that of the arillode, as indicated by the interesting researches of Dr. Planchon, requires to be confirmed by a series of more extensive and careful observations, before it be admitted as a settled fact. The most instructive and conclusive evidence of the origin and subsequent extraneous growth of the arillus over the ovule, has been adduced by Cambessèdes*; he found among the ripe seeds of *Casearia grandiflora* many that were incomplete; and here, although the anatropal ovule showed itself in a state of complete abortion, the arillus had grown over it to its full state of development, proving that where the ovule had ceased to grow, the increment of the funiculus was not stopped in its progress of extraneous production.

Among the instances cited and figured by Dr. Planchon of the development of the arillode, is that of *Clusia flava*, where he describes its ovules as presenting two short cupulary membranaceous appendages, one covering the fourth part of the ovule, the other much shorter and superimposed; and while he inquires, whether one of these cups be due to an expansion of the funiculus, and the other of the exostome, he seems inclined to infer that both proceed from an enlargement of the foramen of the ovule. Such an inference is opposed to the facts described in the foregoing pages, but his observation is worthy of attention, although it is more probable that the appearances he describes are those of a true arillus in progress of its development, the exterior swelling being perhaps that enlargement which I have described as the stipitate foot of the arillus. According to the views of Dr. Planchon, the exterior coating existing in the seeds of the *Clusieæ* must be a true arillus, because the micropyle, which I have mentioned as existing near the hilum of the testa, is wholly covered by that envelope. It is proper to notice that Cambessèdes distinctly asserts that the seed of *Clusia Criuva* is enveloped in its apex by a scarlet cupuliform arillus, in the work last referred to (p. 317. pl. 65. fig. 8), where it is figured upon the extremity of the seed contrary to that of the hilum, and connected with it by a raphe: this assuredly must be an error, made perhaps in transcribing the notes of St. Hilaire, who by such swelling probably intended to figure the cupuliform caruncular process surrounding the diapyle, which I have shown to exist in the same position in the summit of the testa: that such a mistake evidently exists, is proved by the circumstance of Cambessèdes having described and figured the arillus in the *apex* of the seed, instead of being at the *base*, as it would have been had it been in existence. Von Martius (Nov. Gen. et Sp. iii. 166) describes the ovarium of *Quapoya* (*Schweiggera*) as containing "ovula basi arillo vaginata," and Endlicher, upon no other authority than the above, states that the seeds of *Havetia* are "basi arillo subcarnoso laxè cupulæformi cincta," and he assumes upon no better evidence the same in regard to those of *Quapoya*, which in that genus Aublet affirms to be "pulpâ rubrâ involuta."

The facts which I have here brought together, relative to the structure of the seeds in this family, must in a considerable degree change our views of the affinities of the *Clusiaceæ*. They serve to bring the Order into close proximity with the *Rhizobolaceæ*, a relationship founded upon analogies in the floral structure, long ago pointed out by Cambessèdes†, but now rendered still more evident by the great similarity observed in their

* St. Hilaire, Flor. Bras. Mérid. ii. 232. pl. 126. fig. 11.

† St. Hilaire, Flor. Bras. Mérid. i. 323.

extraordinary embryonal development. In this last-mentioned family, the embryo of its exalbuminous seed exhibits, in like manner, a gigantic radicle furnished with exceedingly minute cotyledons; with this difference, however, that the cotyledons here are separated from the great body of the radicle by a slender free neorhiza or neck; but if we imagine the suppression of this neorhizal extension in the *Rhizobolaceæ*, and the close approximation of its minute cotyledons to its monstrous radicular mass, there would be little or no difference in the form of the embryo in the two families. At the same time that these circumstances tend to draw closer the affinities of the *Clusiaceæ* to the *Hypericaceæ* and *Marcgraaviaceæ*, they remove them to a considerable distance from the *Ternstrœmiaceæ*, with which Order they have been hitherto considered to be most intimately related. At present, I will do no more than indicate these considerations, as it is my intention to discuss this question more extensively upon a future occasion, when I treat on the general organography, floral structure, and generic features of the whole Order, restricted as I propose it to be. I will merely observe, that in the course of this investigation, I have met with many singular deviations from usual forms, and numerous interesting facts well deserving of record.

EXPLANATION OF THE PLATE.

Tab. XXVI.

Fig. 1. Seeds of *Lipophyllum latum*:—*natural size.*

Fig. 2. A seed of the same, seen on the ventral face, with the prominent keel which covers the raphe:—*much magnified.*

Fig. 3. The same, seen laterally.

Fig. 4. The same, with the arilliform covering removed, and the raphe separated, showing the testa with its nearly apical diapyle, and basal micropyle.

Fig. 5. Half of the testa of the same removed, showing the inner integument, with its apical chalaza.

Fig. 6. The inner integument, with its chalaza.

Fig. 7. Half of the inner integument removed, exhibiting the position of the enclosed embryo.

Fig. 8. Embryo seen laterally, showing the small cotyledons in the apex, and the prominent striæ upon its surface.

Fig. 9. The same, seen on its ventral face, exhibiting the commissure between the cotyledons.

Fig. 10. The same, viewed from the summit.

Fig. 11. Transverse section of the same, showing the external row of ducts which form the longitudinal striæ; the neorhiza is seen in the centre.

Fig. 12. Longitudinal section of the same, displaying one of the cotyledons, the gigantic epirhizal radicle enclosing the axile neorhiza, which is terminated at its upper extremity by the minute plumule, and at its base by its germinating point prior to its coleorhizal protrusion to form the root of the future plant:—*all also much magnified.*

Fig. 13. A seed of *Lamprophyllum lætum*, enveloped in its pulpy arillus.

Fig. 14. The same, with the pulp dried, and half of it removed, in order to show the enclosed seed.

Fig. 15. The testa seen on its ventral face, displaying its large hilum, and the branching nervures of its imbedded raphe.

Fig. 16. The same, seen laterally.

Fig. 17. The embryo seen on its ventral face, showing the minute plumule in the umbilicated hollow near its summit.

Fig. 18. A transverse section of the same, marking the central neorhiza.

Fig. 19. A longitudinal section of the same, with the axile neorhiza, and numerous viscous ducts distributed through the mass of the immense epirhizal radicle:—*all natural size.*

Fig. 20. A seed of *Tovomita rufescens*, showing on its ventral face the attachment of the arillus to the axile placenta of the fruit.

Fig. 21. The same, displaying the manner in which the free margins of the arillus overlap each other.

Fig. 22. The same, with the arillus removed, seen laterally.

Fig. 23. Embryo, with the testa removed.

Fig. 24. The same, cut longitudinally, to show the plumule and the neorhiza in the axis of an immense epirhizal radicle.

Fig. 25. Portion of the summit of the embryo, showing the minute plumule in the hollow of its apex:—*all natural size.*

Fig. 26. The plumule removed, showing the two very minute external cotyledons.

Fig. 27. A portion of the base of the embryo, showing the radicating point of the neorhiza:—*both much magnified.*

Fig. 28. A seed of *Commirhœa mecocarpa*, seen laterally, enveloped in its fleshy arillus.

Fig. 29. The same, exhibiting on its dorsal face the manner in which the free margins of the arillus overlap each other.

Fig. 30. The arillus removed and spread open, denoting the cicatrix where it is attached to the hilum.

Fig. 31. The testa seen laterally, showing the hilum and branching nervures of the imbedded raphe.

Fig. 32. The embryo, with the testa removed, seen on its ventral face, with its apical umbilicus.

Fig. 33. Longitudinal section of the same, cut through the dorsal and ventral faces, showing the immense epirhizal radicle enclosing the axile neorhiza, and its radicating point.

Fig. 34. Germination of the embryo of *Xanthochymus*, after Roxburgh, exhibiting the prolongation of the plumule, with its basal cotyledons, and showing one radicating shoot springing from the neck of the protruding neorhiza, and another from the basal point; half of the radicle is here removed to display the whole neorhiza, and the mode of its prolongation both upwards and downwards: the radicle thus appears to exert no other function than to afford nutriment to the growing neorhiza:—*all natural size.*

J Miers Esq del.

XXIX. *Extract from a Memoir on the Origin and Development of Vessels in Monocotyledonous and Dicotyledonous Plants.* *By* Dr. Francisco Freire Allemão, *of Rio de Janeiro. Translated and communicated by* John Miers, *Esq., F.R.S., F.L.S. &c.*

Read January 16th, 1855.

In 1849 I began a series of microscopical investigations upon several points of vegetable anatomy, among which was one that attracted my chief attention, because of its greater novelty,—the origin and development of vessels in the roots of plants.

In 1851, I read before the Vellozian Society of Rio de Janeiro a short memoir, in which the most important facts that I had observed were collected, and which appeared to me wholly new to science; at least I have found no record of them in the books within my reach. That memoir, being accompanied by drawings, could not then be printed, but I afterwards revised it, made it somewhat shorter, added other remarks, and suppressed the drawings: in this form it was published in the following year (1852), as the "Third Memoir of my Botanical Exercises:" (*Trabalhos da Sociedade Velloziana*, p. 101).

In the year 1853 I continued the same pursuit, when my attention was not limited to the examination of the growth of vessels in germinating seeds, but was directed also to that of dicotyledonous plants considerably advanced towards a ligneous state: similar observations, extended at the same time to the growth of monocotyledonous plants, convinced me that their mode of development was exactly the same as in Dicotyledons.

This last investigation is not yet completed; it will be of considerable length and accompanied by explanatory drawings, so that I know not when it will be finished: but I send you now an extract from it, with such details as may be requisite to make the drawings that accompany this understood: I am the more anxious to do this, in order to learn whether my observations are new, and worthy of the attention of European botanists, or whether they are already known or sufficiently exact.

The Drawing A. shows the observations upon the growth of a young plant of *Sida carpinifolia.*

Fig. 1 (Tab. XXVII.) represents the plant of its natural size scarcely developed, showing the epigeal cotyledons still enveloped in the seminal integuments. The caulicle (radicle) is linear and without any ramifications, that is to say, without any radicular fibres yet formed.

Fig. 2 shows the same plant much magnified, as observed under the microscope: the cotyledons are thus seen with their nervures formed of tracheal vessels alone, of which two constituting the midrib are continuous with those of the caulicle; these are four in number, distinct, entire, straight, parallel and equidistant, descending into the caulicle as far as *a*: the lower portion of the caulicle does not yet exhibit any vessels, and the radicular bulb, *b*, does not yet show any tendency to form roots.

Fig. 3 is the same plant, still more grown, of its natural size.

Fig. 4 is the same, much magnified, as seen by the microscope. The cotyledons now exhibit their nervures, consisting of tracheæ considerably increased; the gemmule, *c*, is now observed under the form of a cellular tumour without vessels; the four tracheæ in the stem descend in a parallel direction as far as the radicular bulb or bourgeon, *b*, constituting thus the medullary sheath: rootlets are not yet observable.

Fig. 5 represents of its natural size the same plant now having roots, one of the leaves of the gemmule being at the same time fully developed.

Fig. 6 is the same, magnified and divided longitudinally, as seen by the microscope. The cotyledons remain as in the preceding case, with the exception of their having now acquired more nervures: the primordial leaf, *f*, is also seen with nervures consisting of tracheæ only, of which two, constituting the midrib, descend by the stem to meet the four cotyledonary tracheæ: in the stem or primary merithal* (radicle of authors), those tracheæ, *a*, are as yet solitary for two-thirds of the upper portion of their length, but in the lower third they are accompanied and invested externally by dotted vessels, *b*: at the point *d*, the limit between the stem and the root, the tracheæ of the stem terminate, and we see the commencement of the dotted or ligneous vessels, which begin to ascend in bundles through the stem outside the tracheæ, and descend through the roots without being accompanied by tracheæ: *e* is a more magnified figure of half the former vertical section of the mesophyte at the vital point, where at e' is shown the termination of the tracheæ of the stem, and where the dotted vessels are seen ascending through the stem and descending through the main or perpendicular root e'', and also through a ramification of the root at e'''.

From this investigation we may infer the following results:—

1. The tracheæ, which are the first vessels formed, derive their origin in the stem at the vital point or horizontal plane in which the leaves originate, whence they extend, forming bundles, upwards in the leaves to constitute the nervures, which extending downwards through the stem form the medullary sheath.

2. Roots do not exist in the embryos, but are formed in the young plant, when, freed from its seminal envelopes, it penetrates the earth: (there are exceptions to this rule in some embryos, where, from a delay in the rupture of the integuments, the roots begin to sprout while in the seed.) But there exists in such case the root-bud ("*gommo*") or radicular bulb, which is destined to produce it, and which bears some analogy to the gemmule, and may be considered as a primary spongiole, because by its means the plant absorbs nourishment before it has roots.

* According to the doctrine of Gaudich aud (Recherches Générales sur l'Organographie, &c. p. 5), every germinating point or elementary leaf in a plant has its superior and inferior vascular system, the superior or ascending being resolvable into three parts or "*merithalles*," viz. the caulicular (*tigellaire*), the petiolar, and the laminar (*limbaire*), or better designated as the superior, middle, and lower merithals, the line of separation between the two former being called by him the "*mesophyte*," that between the two latter the "mesophylle:" the inferior or radicular descending system is separated from the lower merithal by a point which he calls the "*mesocauléorhize*," which is the primary vital knot ("*nœud vital*") of the stem, constituting its real base, and the true summit of the root.—(*Note of the* Translator.)

3. The fibrous, ligneous or reticulated vessels are of a formation posterior to the appearance of the tracheæ, their origin being at the vital point or horizontal plane from which the roots proceed, and whence they extend in bundles upwards through the stem, till they reach the extremity of the nervures of the leaves, being always exterior to the tracheæ, and downwards through the root till they attain its extremities, leaving almost always in the centre a kind of canal filled with cellular tissue, which is true pith, and which extends itself laterally, communicating with the herbaceous envelope by means of medullary rays: but this pith is not enclosed by tracheæ in dicotyledonous plants; they exist, on the contrary, in the roots of nearly all monocotyledonous plants, where, when true tracheæ do not exist, their place is supplied by mixed or scalariform vessels. I have here carried my deductions beyond the points shown in the drawings, which are now purposely curtailed; but I have made this digression in order to explain my views: with the same object several well-known facts have been repeated: all that appears here really novel is the extension of two vascular systems, in opposite directions to each other, and their increment at their respective extremities, by which is meant the propagation upward and downward of fibres or vascular bundles.

4. Finally, the radicular branches, as appendicular or radiated organs (fig. 6, *e*, *e'''*), are in their origin perpendicular to the cauline fibres, and without continuity with them. This is contrary to the theory maintained by M. Gaudichaud.

Drawing B.—This exhibits the microscopical observations made upon a young rooting bulb of *Fourcroya gigantea*, which tend to prove the facts before affirmed.

Fig. 1: young bulb, of its natural size.

Fig. 2 shows the plane of a longitudinal section passing through the centre of the bulb. Here, in the midst of an apparent confusion of vascular bundles, I obtained the result shown in this figure only after numerous and patient dissections, but the result was repeated frequently. The bulbous mass is formed of rather dense cellular tissue full of a viscous lymph, the cells of which contain much fecula, *i*, and a large quantity of raphides, *i'*, or solitary prisms, *i''*. It gives origin upwards to many sheathing and concentric leaves. Of these the central one, *a*, which is commencing its earliest development, is composed only of very slender cellular tissue: the one next in succession, exteriorly, is still cellular, but beginning to receive tracheal ramifications, which are the upper extremities of numerous simple tracheæ, formed like a crown about the vital point, or horizontal plane, which I have supposed to be the limit between the stem and the leaves, although it is difficult to determine its exact place, as each leaf has its distinct plane, the intervals being true merithalli. These small tracheæ, *b*, are exceedingly slender and of a vermicular or fusiform aspect; they form a seat or curvature in the middle, the convexities of which look toward the centre; thence they extend upwards, penetrating the leaves in great number, parallel to one another, and are prolonged downwards, crossing and placing themselves outside the interior bundles, having a flexuose direction, as shown in *c*, *d*, *e*. In the succeeding leaves there are no simple tracheæ, but numerous tracheæ form bundles or cords, which penetrate in great numbers parallel to one another in each leaf, till they reach the extremity, taking ulteriorly lateral and transverse directions

anastomosing in a very beautiful manner: these vascular bundles or cords also, in their descent, reach the base of the bulb. Now, if we take one of these bundles and examine it in its whole length, viz. the bundle *c*, *d*, *e*, it will be seen that in *c* and *d* it is formed only of tracheæ, and that in *e*, besides tracheæ, it has dotted vessels on the outer side which extend upwards till they penetrate the leaves, *l*, and downwards they are in communication with the root: at *f* is seen a crossing of tracheal bundles, which indicates that the primitive bundles, instead of divaricating from each other, cross in the centre, although I confess that such crossing may not be real, but apparent, and owing to error in observation, notwithstanding that I have seen it more than once: *g* shows a portion of two roots whose vascular system is formed of a certain number of bundles, disposed in a parallel direction with admirable symmetry, among which are seen dotted and scalariform vessels, *h*: no true tracheæ are observable here.

We have in this case proved the same results which are noticed among Dicotyledons: a great number of microscopical observations, made upon various plants under different circumstances, have confirmed these views, which I consider to be unquestionable.

FRANCISCO FREIRE ALLEMÃO.

Rio de Janeiro, December 11, 1853.

Notes by the TRANSLATOR.

The foregoing microscopical observations of Dr. Allemão, which seem to have been carefully made, are deserving of attention, inasmuch as they offer confirmatory testimony of the truth of certain physiological facts which stand upon record. I am enabled by the knowledge of his antecedent researches, published in the Proceedings of the Vellozian Society, to explain his object in making the above communication: he was desirous of testing the validity of the theory first suggested by Du Petit Thouars, and more recently modified and supported by Gaudichaud, which contends, contrary to the views of Mirbel and other eminent physiological botanists, that all woody fibres of the stem proceed from the nascent leaf-buds and thence descend to the radicular extremity of plants. Dr. Allemão states (*loc. cit.* Exerc. Bot. p. 104) that his observations in no way tend to support this theory. The facts, he observes, are best demonstrated in the stem of *Cucurbita Pepo*, where the dotted vessels are extremely large and conspicuous: here no reticulated vessels are found in the ultimate leaves, or even in the last and its nearer internodes (merithalli), although they are found in the lower and older leaves: he observed spiral vessels only in the stems or leaves, as low as the ninth or tenth axil from the extremity of each branchlet; from that point, as low as the fourteenth and fifteenth axil, other vessels are observed in the stem only; but below this point he found them in the stem, and more especially in the leaves, proving that all reticulated and dotted vessels ascend through the stem, before they find their way into the leaves, in their progress of growth upwards. On the other hand, we have evidence long ago established, which may be said to be the touchstone of the various theories that have been advanced on this subject;—the fact of the formation of a circular tumour in the trunk of dicotyledonary plants, above the line of a ligature tightly tied around it. This intumescence is undoubtedly produced

by the depositions left by the descending sap from the woody fibres, where its progress is thus stopped. Hence the question arises, how is it that fibres ascending from the collar of the root create this deposit above, and not below the impediment? Dr. Allemão thinks this may be accounted for by reasoning on the facts established in the preceding memoir, viz. that in the development of the vascular fibres observed in the stem, there always exists a vital centre, whence they extend themselves in two opposite directions. Now this vital centre*, or central point in the formation of fibre, may be fixed, moveable, or accidental: fixed in woody fibres, moveable in tracheæ, and accidental in all adventitious formations. If, for instance, we take a cutting of any young branchlet in which no natural bud is distinguishable, and plant half of it in the ground, several vital points that may be considered adventitious make their appearance, the lowermost of which will give out rootlets, and the uppermost leaf-buds. Is it not therefore clear, asks Dr. Allemão, that in the "vital zone" of this cutting, vital points or centres appear, which would never have existed in the natural condition of the branch? Applying this fact to the case of the ligature before mentioned, it is evident that the cambium or elaborated sap, or whatever be the source of the tumour deposited between the wood and the bark, must assuredly proceed from the leaves toward the root, and meeting with this obstacle, becomes accumulated there: its tendency to organize itself not being distributed, a zone of adventitious or occasional vital centres appears in that point, whose two forces are soon manifested; the ascending fibres continue to extend themselves without impediment, while those which should have descended, unable to overcome the impediment presented to their further progress, continue to grow, twisting and interlacing themselves so as to form a tumour. Under this point of view, Dr. Allemão concludes that his principle of a vital centre is established.

I cannot perceive any essential difference in these conclusions from the views of Gaudichaud, who contends that all the various organs of plants spring from the development of buds generated around the central medullary sheath of the stem, producing by their extension beyond the surface of the stem, leaf-buds, out of which proceed leaves, scales, calyces, corollas, stamens, carpels, ovules, cotyledons, &c., which are each only so many modifications of one original vegetation—the phyton. These buds exist either in an active or a passive state, and being in the latter case only rudimentary, they often remain in the embryo-state of an organized cell, which may at any time under certain circumstances become active. He shows that each active bud has a development of its own, expanding in two opposite directions; upwards to form fresh leaves, inflorescence, &c., and exhibiting principally spiral vessels; and downwards by means of dotted or scalariform vessels towards the roots, producing in their progress depositions of woody fibre, which annually increase the diameter of the stems. Dr. Allemão's general remarks tend to confirm these

* This same term, "*nœud vital*," was, I believe, first used in 1830 by Turpin (Mém. Mus. xix. p. 16) to express the latent bud, whether existing in the stem, in suckers, or in underground tubers, each "*nœud vital*" being analogous to the embryo of the seed, and giving origin to two distinct systems of vessels, one ascending, the other descending. He showed that the tubers of the Potato and Topinambour are true subterranean stems, furnished with numerous distinct "*nœuds vitaux*," commonly called "eyes," which are altogether wanting in the *Convolvulus Batatas*, the tuber of which is simply an expanded root.—J. M.

facts, although in the preceding communication his observations relate only to the development of the primary bud of an individual plant, that is to say, of the growing embryo of a seed. He observes (*loc. cit.* p. 105) that Mirbel in one of his latest essays on this subject (Acad. Sc. Paris, June 1843), in opposing the views of Gaudichaud, demonstrates the fact that the circulating vessels ascend from the point of their origin in the stem, and thence extend to the leaves, but that he does not here distinguish the difference between tracheal and dotted vessels; while, on the other hand, Gaudichaud comprehends in his descending system the same vessels, both vascular and fibrous: his own observations, however, conform only with the theory of Gaudichaud inasfar as regards the propagation downwards of tracheal vessels, and with the latest views of Mirbel relative to the propagation upwards of dotted or fibrous vessels; and they are opposed to both, in respect to the evolution of each fibre upwards and downwards in opposite directions*. There appears to me here a misprint, or complete misapprehension of the views of Gaudichaud, who clearly traces the source of each bud, not from the point of external growth, as Dr. Allemão seems to infer, but, as I have above remarked, from the seat of its origin around the medullary sheath, at the "*nœud vital*," or point of departure of each independent ascending and descending system of vascular fibre. The origin of numerous distinct bud-formations around the medullary sheath, and the extension of ascending spiral vessels and of corresponding descending dotted vessels from each of these separately, are maintained throughout by Gaudichaud in his 'Recherches Générales' as an essential part of his theory; and these are minutely demonstrated in pl. 7. fig. 41, 42, 44, pl. 8. fig. 4, 5, 6, &c., in dicotyledonous plants, and in pl. 9. fig. 1, 2, 3, 4, and pl. 10, in monocotyledonous plants. In support of his theory he also gives numerous other illustrations, even forcibly quoting the same circumstances of the intumescence of a stem produced by a ligature, and the germination of an apparently budless stem, both which facts Dr. Allemão considers to strengthen his own views in opposition to those of Gaudichaud.

A precisely analogous development to that delineated in the preceding memoir was pointed out by Mirbel in 1809, showing the origin and formation of similar vessels in the germinating seeds of *Nelumbo* (Ann. Mus. xiii. 471. pl. 34. fig. 19), where they are depicted as originating from the neck of the plumule, and branching thence into the nervures of the cotyledonary leaves, while others tend downwards into the growing radicle: these several vessels were first observed by Bonnet, and described by him as "mammary vessels," as far back as 1754. Mirbel described all these ascending vessels to be of spiral structure, and the others tending to and through the roots, to be strangulated or dotted vessels, which, though incapable of being unrolled, he considered to be only modifications of the spiral form, an opinion which he afterwards somewhat modified. Long prior to this (in 1802), Mirbel read a memoir to the Institute, expounding these facts; and we find a very concise account by Desfontaines, of these able researches, in the 5th volume of the 'Annales du Muséum', p. 80, with two elaborate plates, showing the ascending system of spiral

* His words are, "conforma se com a theoria de Señor Gaudichaud quanto á propagação de alto á baixo, sómente para as tracheas; e com as observaçoẽs ultimas de Mirbel quanto á propagação de baixo para cima, mas unicamente para os vasos pontuados e lenhosos; e emfim differe de todas quanto a evolução de cada fibra em sentidos oppostos para cima e para baixo."

vessels in the plumule and cotyledons, with the descending system of dotted vessels in the radicle, as distinguished in the germinating embryo of the common French Bean.

Another fact related by Dr. Allemão is, that although the "*bolbo radicular*" is always the main growing point of the radicle, he observed in *Euphorbiaceæ*, four other cruciform branches on one horizontal plane, proceeding from this radicle. This fact is not novel, for it was noticed more than forty years ago by St. Hilaire (Ann. Mus. xix. 468), where he describes the same feature in the germination of a Ranunculaceous plant (*Ceratocephalus*): here the main shoot is shown, growing in the ordinary way of an exorhizal root, but four other branching rootlets are produced on one plane, from the collar of its young root, which make their appearance through lacerations of the external tunic: their earliest indication is in the form of tubercles, through the investing covering of which these rootlets burst a passage, in all respects like the coleorhiza observed in the germinating embryos of monocotyledonous plants, so that, although the main root here is exorhizal, the secondary rootlets are distinctly coleorhizal. This coleorhiza is sometimes extended to some distance, along with the rootlet; but in other cases it forms merely an areola around its base. St. Hilaire observed the same appearance in the growing embryos of numerous other exorhizal plants, as those of *Plantago*, *Valerianella*, *Urtica*, *Senecio*, *Sonchus*, *Calendula*, *Matricaria*, *Veronica*, *Phaseolus*, *Medicago*, &c., although it is not of general occurrence. In the singular mode of germination of the seeds of *Tropæolum*, the radicle, though exorhizal, exhibits a kind of valve-like opening for the exit of the plumule, which has been called a coleorhiza: a somewhat similar appearance is said also to occur in the germination of the seed of *Viscum album*, but that I apprehend can refer only to the coleorhizal mode of bursting of the attenuated expansion of the thin covering of the albumen which is spread over the growing radicle.

Dr. Allemão here considers the radicle of the embryo as part of the caulicle or stem, and the root as originating in the subsequent growth of the embryo, after it is released from its integuments, and produced by the expansion of the obtuse extremity of the radicle, which he calls the "*gommo*," and Gaudichaud the "radicular bulb." This view was also taken by Turpin nearly twenty years ago, and is figured as such in the germination of *Solanum tuberosum*, where all the radicular portion of the embryo is considered as the *tigelle*, or part of the ascending system, while the true root is shown to begin from its sprouting point, called by Dr. Allemão the "*bolbo radicular*," or "*gommo*." This idea, though supported by some, has not been much countenanced, and I do not perceive the advantage of this theory over that more generally received, which assigns to the radicle the function of the elementary root, its commencement being at the point of union of the cotyledons and their junction with the plumule. The contrary hypothesis is disproved by numberless facts, and more especially by one to which I lately called the attention of the Linnean Society, the germination of the embryo of *Xanthochymus*, as figured by Dr. Roxburgh, where, in addition to the principal root thrown out at the base of the seed, at the point which Dr. Allemão would call the radicular bulb, another secondary root is seen sprouting from the summit of the nucleus, out of the ascending collar or *tigelle*, immediately below the scales which appear to be the minute cotyledons, showing that the

main body of the nucleus or radicle belongs to the descending system of the root. It is more natural to conclude, in the case cited by Dr. Allemão, that the main descending shoot growing out of the radicular bulb, and also the subsequent coleorhizal rootlets, are productions of that axile portion of the radicle which I have called the "neorhiza;" and under this point of view it is easy to account for the coleorhizal character of the secondary rootlets in the germination of *Ceratocephalus* described by St. Hilaire, which, as a natural consequence of this structure, would assume that appearance. A very singular example of this sort of production is shown by Klotzsch in the germination of the seeds of *Pistia**, where the many secondary rootlets or branches of the neorhiza force their way through the epirhizal covering of the main root, extending it as a coleorhiza, in the form of a long cylindrical tube, which at length breaks away, leaving a long sheath in the form of a thimble covering the extremity of each growing rootlet, and which probably thus performs the function of a spongiole.

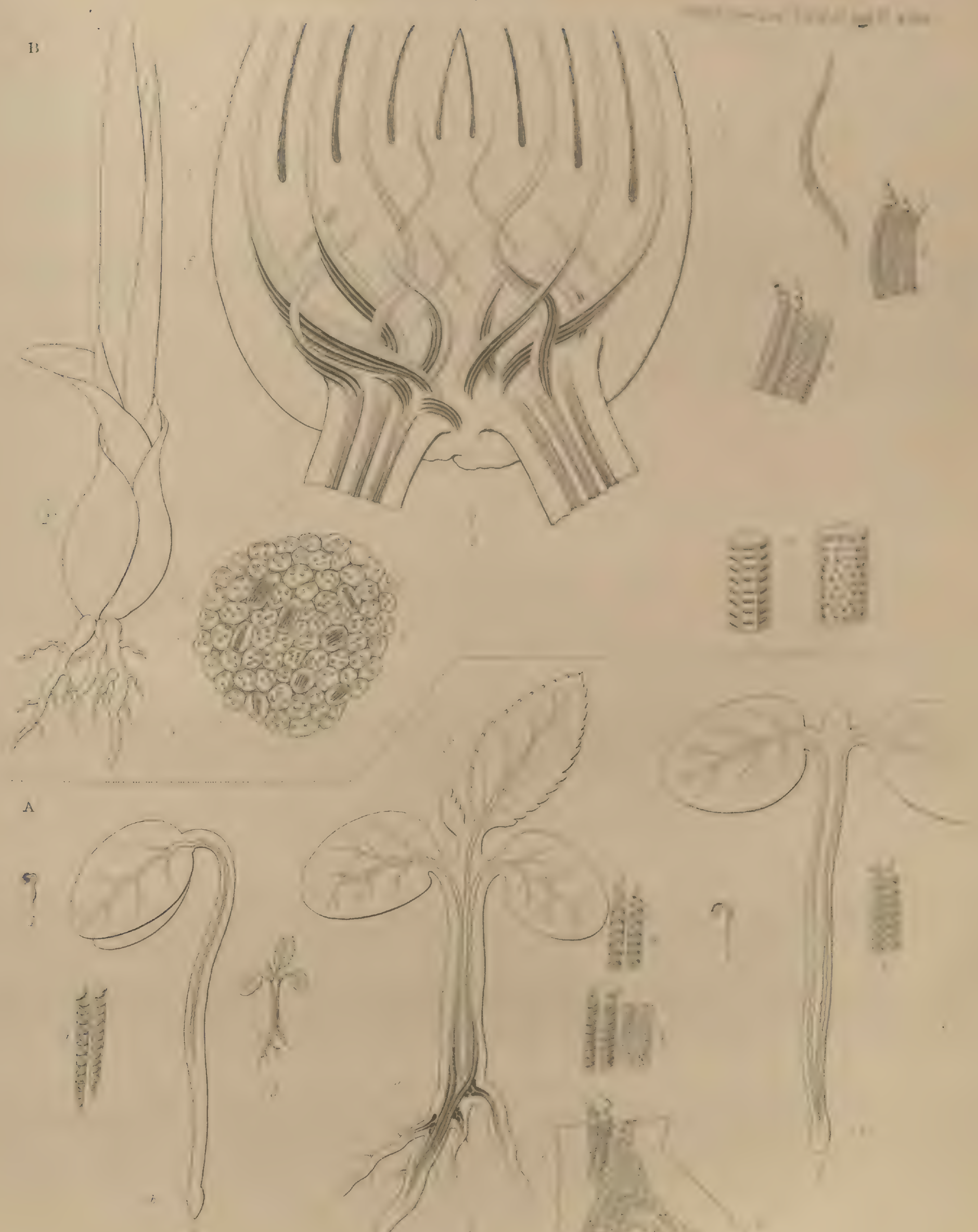
J. Miers.

* Über Pistia. Berlin, 1853. Plate 1. fig. C, D, E.

EXPLANATION OF THE PLATE.

Tab. XXVII.

The explanation of the several figures is given in the text of the Memoir.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XXX. *Description of* Peachia hastata, *a new genus and species of the Class* Zoophyta; *with observations on the Family* Actiniadæ. *By* Philip Henry Gosse, *Esq., A.L.S.*

Read March 20, 1855.

In the month of January 1854, and afterwards in March of the same year, the Rev. Charles Kingsley found, in the vicinity of Torquay, many specimens of an *Actinia*, which he kindly forwarded to me. As it appeared not only to be an undescribed species, but to have characters which separate it generically from others, I venture to lay before the Linnean Society my observations concerning it.

The body (Tab. XXVIII. fig. 1) is spindle-shaped or clavate, 4 inches in length, and 1 inch in greatest diameter, pellucid, very pale red, with numerous slender whitish lines, running at equal distances down the whole length. These do not vary in width, and are evidently the edges of the internal septa, seen through the translucent integument. The red colour is dependent on a thin epidermis, which, as the animal is apt, when in a sickly state, to distend itself greatly in parts, bursts, and separates into torn shreds, displaying the pellucid body beneath.

The oval disk is very protrusile; it is surrounded by a single circle of twelve (eleven in one specimen) tentacles. These are short, thick at the base, tapering to a point; and are frequently carried recurved over the margin, like rams' horns (fig. 2). Their markings are peculiarly elegant. Each tentaculum is pellucid-white, as to its ground colour; but its upper side, or that which faces the disk, is variegated with arrow-heads of white and brown, in two parallel lines (fig. 3). The arrows point towards the base of the tentacle, and the colours are arranged alternately, one of white with one of brown fitting into its angle, and so on: there are about six of white and six of brown in each of the two rows; but towards the extremities they have a tendency to become confluent.

The disk is somewhat similarly marked with arrows or vandykes; but they point in the opposite direction towards the circumference. The arrows of the outermost circle are strongly marked, and form a star or flower of twelve points, of deep brown; of which the points diverge again, to embrace partially the bases of the several tentacles. Within this circle there is a similar one of white, and within this, another of small brown arrows, which are not united.

The mouth is very evertile, but does not rise into a cone. Its lips are grooved interiorly, and the grooves are deep brown, and appear to be confluent at some distance down the throat. From the mouth protrudes a singular organ, to which I know of no parallel in this class of animals. It is a sort of fleshy proboscis, the tip of which dilates into a clubbed head, divided into short papillæ (figs. 2 *a* and 4 *a*). The papillæ were about twenty in number in my largest specimen, with a tendency to form groups, slightly radiating; each papilla consisting of a pellucid sheath and of a dark brown core.

This curious apparatus appeared to form one side of the mouth,—to be, in fact, an enlargement of the paries or lip, at one part of the circumference, with nothing corresponding to it on the opposite side. It was perforate, and, as I conjecture, led down to the visceral cavity of the body, external to the stomach, constituting the orifice through which the ova or young are ordinarily deposited. In the smallest specimen I could not detect more than four or five of the cored papillæ on this prominence. Under a lens, when the animal was sickening, and the lips were much protruded and everted, the organ was evidently seen to be a tube, with thickened walls, enclosed within one paries of the œsophagus, and with its margin studded with papillæ. Into the orifice, which was corrugated, I could thrust a bristle with ease. Fig. 5 represents the mouth in this condition.

The natural habits of this Zoophyte, as seen in freedom, are thus graphically described by Mr. Kingsley in his letters to me. "They lie (or rather stand) in wet, ribbed, clean sand, at low-water mark, the disk just out of ground. On digging carefully (for the animal retracts on the least shaking of the sand), you find that he is buried bolt-upright to the depth of 9 inches, where his extremity stops; the whole animal tapering gradually from stem to stern. On being taken out (no easy matter, since its power of retraction, if irritated, is far more rapid and springy than in any of the class, as far as I have tried them), and put into a vase of salt water, he swells himself out with water like a Holothurian, disclosing longitudinal septa. He also has a tendency to transverse constriction, like *Scolanthus* and *Chirodota*; but this has gone off in my specimens. All his motions (at least before he has made a cold bath of his own skin by taking in water) are rapid and spasmodic; betokening, as does his whole make, a higher muscular organization than that of the *Actiniæ*."

None of the specimens made the slightest attempt to adhere; nor did the posterior extremities show any appearance of a sucking disk. There was, however, a strong corrugation in that part, radiating from a central orifice, into which I thrust the point of a pin without resistance to the depth of $\frac{1}{8}$th of an inch.

All the three specimens which first came into my hands were more or less languid and sickly when I received them. One of them was swollen into a balloon-like form, and never expanded the tentacles at all. The others soon became invested with a thick tenacious mucus, and though they retained the power of expanding and retracting the tentacles, they burst the integument in one or more wounds, so that the convoluted bands protruded. The latter organs were present in copious profusion, broad bands very much frilled, with a slender "beading" or thickened border, which the microscope showed to be moderately filled with minute slender thread-capsules, about $\frac{1}{900}$th of an inch in length, slightly curved; they discharged the thread freely, but with unusual slowness, the lengthening of the tip resembling the progress of the minute-hand of a watch. One that I measured, of an average length, extended to about $\frac{1}{50}$th of an inch, or eighteen times the length of the capsule.

All these individuals successively became defunct by a sort of spontaneous dissolution of the parietes of the body. The integument seemed to change into a viscid mucus, and presently burst in many places, allowing the convoluted bands to protrude so copiously

as to conceal and envelope the body. As this protrusion proceeded, I found that these bands were not the ovaries, as I at first supposed, but were attached to them. The ovaries were protruded also in the form of thick tubes, much convoluted, and of a salmon-colour, studded with minute white specks. These tubes were filled to distension with their contents, and were consequently plump, at least at one edge; for, as well as I could judge, they ran off at the opposite edge into a broad, exceedingly attenuated, gelatinous ribbon. Along the thickened and tubular edge was attached the capsuliferous band, as a mesentery; this also having a thickened margin, but differing in structure, as well as in appearance from the former. It was narrower and much more convolved; the edge lying in pretty regular figure-of-8 turns, or scrolls, like the frill of a cap; the colour of this band was dull yellowish, with the thickened border white. This border was, as I have said above, principally composed of thread-capsules; but in the salmon-red tubes I found none of these organs. They were filled with ova, enveloped in a red mucus, which gave the colour not only to the tubes themselves, but also to the body of the animal. These ova were globose or pear-shaped bodies, very soft and elastic, the largest measuring $\frac{1}{65}$th of an inch in length, by $\frac{1}{100}$th in diameter; while others (of the globose form) probably less advanced, were not more than $\frac{1}{175}$th of an inch in diameter. Indeed they rather resembled the planules of a *Plumularia* or *Antennularia* than proper ova, except that they had no motion, and were not ciliated. They consisted of a granular brown substance, becoming clear and colourless at the circumference. I could see no trace of a nucleus in any, either with or without pressure.

The animals, so burst and apparently dead, I allowed to remain in a dish of pure sea-water, with a growing leaf of *Ulva*, to preserve its vitality. To my surprise, they at length were evidently everted, *turned* (by the continuance of the process of protrusion through the ruptured integument) *completely inside out*, so that the membranous septa of the interior now projected from the circumference; while from each interseptal space protruded the convoluted ovaries, with their mesenteries and frilled bands. Nor did it appear that death had really ensued. As an animal, an individual, I could not consider it otherwise than deceased; for it was become a shapeless mass of viscera, from which the original integuments were sloughing, in films of glairy membrane. But no putrescence had set in; and on examination with a lens, through the sides of a glass vase, to which I had early removed the specimens, I found in each one, twelve days after they had been in this dissolved state, that the ovaries maintained a perfectly clear, plump, healthy appearance (fig. 6), with a more vivid rose-tint than at first; and that the frilled bands were slowly, but constantly, moving all over them; puckering and unfolding their involutions, and altering their forms, by means of the cilia with which they were covered;—a beautiful provision for the respiration, so to speak, of the yet undeveloped embryos, by the perpetual passage of currents of the surrounding water along the ovaries.

I was thus forcibly reminded of the mode in which the oviposition is effected in that little lovely Medusa, *Turris neglecta*,—by the protrusion of the ovary, and the eversion and gradual dissolution of the umbrella, as I have elsewhere described and figured*; a process, which I have now reason to believe is common to the higher kinds, at least, of

* Devonshire Coast, p. 352.

the Pulmograde Medusæ, since I have observed it in several of the Covered-eyed genera. The affinity between the Arachnoderm and Actinoderm classes of RADIATA was already known to be close; and these curious facts may add another link to the connexion.

If the rupture and inversion of the body in this instance was a normal process, it still would not be inconsistent with the function which I assign (from analogy with other *Actiniadæ*) to the curious papillated duct at the side of the mouth. Ova or living young may be discharged through this orifice, at intervals, during life, and yet the most prolific birth may be reserved for the period of the parent's decease, when the whole contents of the ovaries are committed to the waves.

Whether it was so or not, however, I did not ascertain; for, about a week later, or eighteen days after the evolution, I perceived that the mucous integuments were decomposing and becoming offensive. The ovaries and their bands wore nearly the same appearance as before; but some of the former were dispersing in flocculent shreds, in which I could not detect any embryos more advanced than those which I had before examined. The frilled bands maintained spontaneous motion, but very slow. I therefore took the specimen from the vase and examined it. I found it completely inverted; the tentacles were set around the interior of one extremity, and the papillated orifice at the edge of the mouth was very distinctly seen. The papillæ are arranged around the orifice in flat hand-like eminences, each containing three or four papillæ, resembling fingers. The dark-brown cores, so well-defined that they look like solid bodies, under pressure appear to consist of pigment-cells or granules, of similar consistence to that of the surrounding flesh.

The anal extremity was much more distinct than before; the orifice being $\frac{1}{8}$th of an inch in diameter, and perfectly defined, with striæ radiating from its margin, and the thickened septa commencing in a circle around it.

No sac-like fundus was visible to the stomach, but it seemed to merge into the visceral cavity, as described by M. Hollard (Ann. des Sci. Nat. 1851), and by Dr. Cobbold (Ann. Nat. Hist. 1853); differing only in the fact just mentioned, *that this cavity had a posterior orifice.*

The possession of an excretory orifice to the body is a character of sufficient importance to separate this species from the genus *Actinia.* I therefore propose to constitute a genus for it, by the name of *Peachia*, as a tribute to the zeal, industry, and success with which marine zoology has been studied by Mr. Charles W. Peach. I am influenced in this selection of a name, also, by the circumstance that a species discovered by that gentleman in Cornwall, and named by him *Actinia chrysanthellum*, appears to resemble the present species closely, and may prove to belong to the same genus. It is very minute, whereas this is a zoophyte of large dimensions; and the describer has not mentioned the existence of a posterior orifice, nor of any papillated structure in front. The former may, however, have been overlooked.

The genus and species may be thus characterized:—

PEACHIA, *Gosse.*

Corpus elongatum, subcylindricum, pyriforme, v. fusiforme, ditrematum, liberum; *tenta-*

culis paucis, brevibus (disci diametrum haud superantibus), crassis, conicis, uniseriatis; *oviductu* in tuberculum papillosum desinente.

1. PEACHIA HASTATA (*Gosse*), corpore roseo lineis æqualibus pallidis, tentaculis 12 albo-hyalinis seriebus 2 parallelis macularum sagittatarum brunnearum notatis, disco circulis duobus macularum brunnearum V-formium cincto, oviductûs papillis numerosis aggregatis.

2?. PEACHIA ? CHRYSANTHELLUM, corpore cylindrico albido lineis inæqualiter latis, tentaculis brunneo annulatis.

Actinia chrysanthellum, Peach.

The principal interest of this form is the decided approach which it makes to a higher type of existence than that of the ACTINODERMATA. The sensitiveness to alarm, and the spring-like rapidity of its motions, indicate a greater condensation in the nervous and muscular systems; but the existence of a posterior opening to the digestive canal is a still more decisive advance in structural rank. The approach to the ECHINODERMATA, through the *Sipunculidæ*, is marked, not only by this important character, but also by form, by the degeneration of the tentacles in number and dimensions, and by the tendency to break up the body by spontaneous constriction.

The genus *Edwardsia* of M. Quatrefages, still further diminishes the interval between the *Actiniæ* and the *Holothuriæ*; for the mouth and tentacula are, in that genus, seated at the end of a delicate column, which is retractile within the coriaceous trunk, as it is in *Syrinx nudus*; and the balloon-like inflation at the posterior extremity reminds us of the same animal. It is curious to trace also, in *Syrinx* itself, an approach to the Actinoderm type, in the digestive canal terminating near the head, the greater portion of the body being imperforate.

I may observe, in passing, that the genus *Edwardsia* is represented by two British species. One was described and figured by myself in the "Annals of Natural History" for Sept. 1853, under the name of *Scolanthus callimorphus*; but, as I am now convinced that notwithstanding the apparently simple posterior extremity in that species, it must be referred to *Edwardsia*, the genus *Scolanthus* must be cancelled. The name will hence become *Edwardsia callimorpha*. Another species is described by Mr. Kingsley (*in litt.*), which appears to be *E. Beautempsii* of M. Quatrefages.

I will embrace this opportunity of making a few observations on the more typical *Actiniæ*. Restricted as is the genus *Actinia*, by the separation from it of *Adamsia* and *Anthea* among British, of *Metridium* and *Actinecta*, and many others among exotic species, and by the creation of such genera as *Capnea*, *Corynactis*, *Ilyanthus*, &c., it is still so immense a group, that any subdivision of it on sound principles is desirable, especially when we consider the great difficulty of defining species in this tribe. Indeed, I hold that, wherever we find *several* characters *co-existent* in a certain number of species, *none of which are common to other species*, the species possessing such characters ought to be elevated to the rank of a separate genus.

Applying these principles to the group before us, I find a number of *Actiniæ*, which

have the well-marked character of projecting, from pores in the exterior of the body, whenever they are irritated, thread-like filaments, in great abundance and to great length, which are again withdrawn into the body. These filaments, when examined with a high power, are seen to be chiefly composed of thread-capsules, or "nettling-organs;" and I have given elsewhere* evidence to show that their function is that of efficient weapons of offence, paralysing even vertebrate animals, with which they are brought into contact. Every one who has handled *A. parasitica*, *venusta*, or any of the species with missile threads, is aware of the great tenacity with which these filaments adhere to the fingers. This is owing to the penetration of the epidermis by the myriads of ejected threads, and to the hold which their barbed structure enables them to retain. For when these nettling organs are examined, say with a power of 500 diameters, the thread is perceived to be armed in a manner which gives them a superiority over those of all the non-shooting species; and thus the structure of these organs affords us another excellent and constant generic character. There are, indeed, in these species, always to be found many thread-capsules of the *ordinary* form and structure, viz. linear-oblong, emitting a thread which is apparently simple, and of great length, extending to about twenty times the length of the capsule. But the principal portion of the capsules are of another form, being long-oval with a distinct longitudinal chamber, and emitting a thread, never exceeding thrice the length of the capsule, and more commonly one or one and a-half times, as in *A. Bellis* (fig. 10), and in *A. Troglodytes* (fig. 11). The terminal portion of this thread (including from half to more than three-fourths of its length, according to the species) is barbed with close-set bristles radiating on all sides like the hairs of a bottle-brush, and more or less reverted. In *A. venusta* (fig. 7), a zigzag lineation is discernible on the thread, which seems to indicate that the hairs are set on in a spiral arrangement. Before emission, the thread-chamber is very distinct in this species (fig. 8), running through the whole length of the capsule, slightly bent in a sigmoid curve, and gradually merging into the capsule-walls at the discharging end. In some instances the thread is discharged, in every respect agreeing with that just described, but perfectly simple and without barbs (fig. 9): I think that this occurs when the emission has been very slow; that the barbed hairs fly out only when the missile force is sudden; that, otherwise, they continue appressed to the sides, and invisible. I can discover no trace of the spiral in the un-emitted thread.

This brush-like form of the nettling-thread I find in ten of our native species of *Actinia* (which I shall presently enumerate), invariably co-existent with the power of emitting filaments spontaneously. They are marked also by other characters, of less importance because less definite:—the tentacles are generally of small size, slender, numerous, and much crowded; the body is soft, rarely coriaceous, and smooth, though commonly perforated with sucking glands, which are distinct from the emitting pores; and the colours of the body often have a tendency to run in longitudinal bands, and those of the tentacles to form arrow-heads. The genus thus characterized I propose to call *Sagartia*†.

The remaining British species (for I beg it to be observed that I am speaking only of

* 'Devonshire Coast,' *passim*; 'Aquarium,' pp. 115, 143, 148.

† "There is a certain nomadic race called Sagartians. . . . The mode of fighting of these men is as follows:—

such as I have had opportunities of personally examining) may be distributed into two groups. The first contains such species as have the body studded with warts; the skin coriaceous; the tentacles moderately few, generally thick, conical, and obtuse, and for the most part marked on their facial surface with transverse dashes of opaque colour. They do not discharge filaments under any annoyance (when wounded, however, the convoluted ovarian bands protrude); and the nettling threads of their tissues are long and simple, or at least never brush-like. That of *A. crassicornis*, indeed, is armed at its base, as I have represented it elsewhere*; but it is in a manner peculiar to itself, and totally unlike that of the *Sagartiæ*. This fine species deviates, in some other subordinate particulars, from the rest of the verrucose *Actiniæ*, and may possibly require ultimately to be separated. For the present, however, I include it in this genus, which I propose to call *Bunodes*†.

There now remains a group, for which, as it includes the most abundant of our species, the everywhere-familiar Smooth Anemone (*A. Mesembryanthemum*), I would retain the appellation of *Actinia*. In addition to this well-known species we have two others on the British shores, which I shall presently mention. Besides the negative characters which mark these species—the absence of emitted filaments, and of surface-warts,—they have a distinct positive one, in the existence of a series of spherical or oval bodies, of unknown function, seated between the outermost row of tentacles and the margin of the disk. In our native species these are conspicuous, from their opaque blue or white colour; but in exotic species, they occur of other hues. In *Mesembryanthemum*, the ovarium-bands, and the walls of the tentacles, are furnished with comparatively few thread-capsules, which are linear, and very small; those of the bands being about $\frac{1}{700}$th of an inch in length, and those of the tentacle-walls not more than $\frac{1}{1200}$th; whereas the ovate capsules of the *Sagartiæ* run from $\frac{1}{350}$th (*Dianthus*) to $\frac{1}{875}$th (*parasitica*); the length in most of the species being about $\frac{1}{500}$th.

The marginal spherules, however, are almost wholly composed of capsules, very linear, and about $\frac{1}{390}$th of an inch long. They very reluctantly emit the thread, which I have therefore seen only in few instances. It is very subtile, and of considerable length; but I was not able in any case to trace it to its termination. From these facts I incline to think, *that the marginal spherules of Actinia may represent, in function, the missile filaments of Sagartia* ‡.

Among subordinate characters of this genus may be mentioned the very delicate and smooth skin, destitute of both pores and sucking glands. The disk and tentacles are

when they engage with the enemy, they throw out ropes, which have nooses at the end; and whatever any one catches, whether horse or man, he drags towards himself; and they that are entangled in the coils are put to death."—Herodotus, vii. 85.

* 'Devonshire Coast,' pl. xxviii. fig. 19.

† Βουνώδης, *verrucosus, clivosus.*

‡ M. Hollard cannot conjecture the function of these marginal spherules. "Their position at the circumference, the volume and great transparency of their capsules, their existence in a species eminently littoral, exposed, and very sensible to the variations of the atmosphere, when the sea is out,—do not these circumstances indicate some physiological relation between these little organs and the action of light?"—(Ann. des Sci. Nat. 1851, p. 272.)

Has not M. Hollard, however, overlooked the fact, that the spherules *are never exposed to the atmosphere*, since the disk is expanded *only under water*?

unicolorous; as is also the body generally, though this is sometimes varied by lines or spots of another colour, which are by no means constant; a line of different hue more commonly encircles the base. The tentacles are moderately numerous, of medium thickness, tapering to a point.

These three genera may be therefore defined thus:—

1. SAGARTIA, *Gosse.*—*Actiniæ* basi adhærentes; *tentaculis* conicis, facilè retractilibus; *sphærulis* marginalibus nullis; *corpus* everrucosum, *filamenta capsulifera* e poris emittens; *filis urticantibus* brevibus, pilorum fasciculo densè armatis.

British species, *viduata* (=*anguicoma*, Price), *Troglodytes*, *Aurora*, *candida*, *rosea*, *nivea*, *venusta*, *parasitica*, *Bellis*, *Dianthus*. Probably also *aurantiaca* and *pulcherrima* of Professor Jordan. The following exotic species, figured by Dana in the Zoophytes of the American Exploring Expedition, seem to be referable to this genus:—*Primula*, the beautiful *decorata*, and *Fuegensis*, both allied to our *Bellis*; and *Achates*, *reticulata*, and *Paumotensis* (perhaps the most magnificent of the whole tribe), which are evidently allied to *Dianthus*.

2. BUNODES, *Gosse.*—*Actiniæ* sphærulis marginalibus nullis. *Corpus* verrucosum; *cute* coriaceâ, *filamentis* missilibus nullis; *filis urticantibus* longis simplicibus; *tentaculis* plerumque crassis, conicis, obtusis.

British species, *gemmacea*, *thallia*, *clavata*, *crassicornis*, *Monile* (probably the young of *crassicornis*)?, *Chrysoplenium*?, *alba*?, *miniata*? Of exotic species, *Diadema*, *pluvia*, *Gemma*, *Artemisia*, of Dana's Zoophytes, probably come here.

3. ACTINIA, *Linn.*—*Sphærulæ capsuliferæ* ad disci marginem seriatæ. *Corpus* everrucosum, *poris filamentisque missilibus* destitutum; *cute* lævi.

British species, *Mesembryanthemum*, *margaritifera*, *Chiococca*. Exotic species, *Tabella* and *graminea* of Dana.

The following British species are of doubtful place;—*coccinea*, *intestinalis*, *biserialis*, *vermicularis*. The very curious *biserialis* of the late lamented Professor Forbes has a close parallel in the *Rhodora* of Dana; and these may perhaps form another genus, when more is known about them. *Intestinalis* and *vermicularis*, both from the Shetland seas, show, in their slender lengthened form, an approach to the free condition of *Peachia*, &c. The latter of these is a deep-water species (eighty fathoms); and, as Professor Forbes observes, looked when unattached "more like a planarian worm than an *Actinia*."

The following table exhibits one manner in which the British noncoralligenous *Actiniadæ* may be artificially distributed:—

- Adherent ...
  - Tentacles gathered into groups .... ***Lucernaria.***
  - Tentacles continuous.
    - Tentacles scarcely retractile.
      - Adhering base entire .... ***Anthea.***
      - Adhering base annular .... ***Adamsia.***
    - Tentacles readily retractile.
      - Tentacles capitate .... ***Corynactis.***
      - Tentacles truncate .... ***Capnea.***
      - Tentacles conical
        - emitting filaments .... ***Sagartia.***
        - without filaments
          - warted...... ***Bunodes.***
          - smooth ... ***Actinia.***

Non-adherent	Monotrematous	Anterior extremity normal	*Ilyanthus.*
		Anterior extremity forming a retractile column	*Edwardsia.*
	Ditrematous		*Peachia.*

If we take *Sagartia* as the typical genus, which its superior populousness, and the perfection of its armature entitle it to be considered, we may trace, as from a central point, some of the relations of the *Actiniadæ, inter se*, as well as with other forms.

Adamsia comes very close to *Sagartia*, possessing the power of emitting filaments in high perfection: probably the point of union between these genera will be *S. parasitica*; which, like *Adamsia palliata*, attaches itself to shells in which *Paguri* dwell; and which is pre-eminent in its genus for the abundance and the tenacity of its filaments. The passage from *Sagartia* to *Bunodes* is perhaps through *S. Dianthus* and *B. clavata*; the disk of the latter being very expansive, with the tentacles situated at its margin. *S. Bellis*, in its power of assuming a saucer-like form for its thin expanded disk, to which the narrow body serves as a foot-stalk, shows also a remote approach to *Lucernaria*, in which this figure is permanent.

Lucernaria exhibits a beautiful link of connexion between the Actinoderm and the Arachnoderm forms of Radiata. The *Oceania turrita* has its umbrella produced into a long moveable spire, which looks exactly like a foot-stalk, by which it had been attached when in a polype condition; while in *Bougainvillæa* we get the numerous tentacula gathered into groups. The mobile, four-lobed mouth of *Lucernaria* closely resembles the peduncle of a Medusa.

There is a curious analogy (I fear it is nothing more) between *Lucernaria* and the genus *Floscularia* among the Rotifera: both are attached by a slender pedicel; both have a flower-like disk, jutting out into angles, which are beset with a multitude of filaments (tentacles in the one case, setiform cilia in the other) that radiate in all directions.

The tender and soft-bodied little *Sagartia candida* and *S. rosea* seem to lead off to *Corynactis Allmanni*, though the points of resemblance are rather general than special. But this latter genus passes into *Capnea*, by a remarkable species described by Mr. W. Thompson of Weymouth, in the Zoological Transactions for 1853, under the name of *Corynactis heterocera*, and which I had an opportunity of examining while alive. Professor Forbes has observed the close affinity of his *Capnea sanguinea* to the *Zoanthadæ*, and the transition which the latter exhibit to the creeping and budding Hydroid polypes is sufficiently apparent. *Corynactis*, in its capitate tentacles, shows also a relation to *Cyathus Smithii*, among the coralligenous Anthozoa; while the simply-conical form of these organs in *Balanophyllia regia* agrees with *Actinia*, &c.

The transition from *Sagartia* to *Actinia* proper, I do not know how to trace, except by characters common to the whole group. The soft-bodied species of the former genus, which do not possess sucking glands, as *candida, venusta* and *nivea*, are however certainly more closely allied to the smooth-skinned *A. Mesembryanthemum* than such coarse species as *S. Bellis, parasitica*, &c., and this is all I can say.

I think, however, that *Actinia* makes a decided approach to *Lucernaria*, in the capsuliferous spherules of the margin; for the oval appendages which are placed on the edge of the disk, in the latter genus, alternating with the groups of tentacles, are, I doubt not, consimilar in structure and function to those spherules.

The nearest alliance of *Anthea* is with *Actinia*; to which, in the texture of its skin, and the absence of warts, pores and glands, it presents a close resemblance. The received notion, that *Anthea* is incapable of entire retraction, I have elsewhere stated to be incorrect; and I have since had several opportunities of seeing it with the tentacles quite concealed, and the animal assuming the ordinary butter-like shape of an *Actinia*. A better character is the tendency which the tentacles have to form groups, like several trunks of a tree united close to the ground. In this respect there is perhaps an approximation to *Lucernaria*; remote, however, for the clusters thus formed are still in contiguity with each other; and the peculiarity cannot be discerned, except when the animal is in the state of widest expansion.

Finally, the species *viduata* appears to be the point at which the genus *Sagartia* leads off towards the ECHINODERMATA. Though, in an Aquarium, it remains attached for months together, yet, in freedom, its adhesion is evidently very slight. It comes on shore by hundreds, after a gale, on the Devonshire coast; and is frequently dredged on sandy mud, sometimes adhering to a small bivalve-shell, but more commonly free, with the posterior extremity contracted, so as to resemble a thick pedicel. It burrows in sand; and, in conformity with such a habit, it has the power of great elongation. A specimen which I have kept for the last six months, sometimes forms a slender column 5 inches in height. From this vermiform creature the transition is so brief to the free *Ilyanthus*, that we hardly need to seek a place for *intestinalis* and *vermicularis*; and from *Ilyanthus* to the genera *Peachia* and *Edwardsia*, of which I have spoken in the former part of this Memoir, and thence to the *Sipunculidæ*, the road is patent.

These relations I have attempted to display by a diagram; though I need scarcely say, that such a representation cannot adequately express the varied consanguinities and cross-alliances of the grand plan of Nature.

EXPLANATION OF THE PLATES.

TAB. XXVIII.

Fig. 1. *Peachia hastata*: natural size.
Fig. 2. The oval disk and tentacles; (*a*) the papillæ of the oviduct: (magn. 2 diameters).
Fig. 3. A tentacle (magn. 2 diameters).
Fig. 4. The disk, with the papillæ (*a*) projecting: (2 diameters).
Fig. 5. The mouth of another specimen, showing the orifice of the oviduct: (4 diameters).
Fig. 6. A portion of the ovaries, with the convoluted bands: (10 diameters).
Fig. 7. Thread-cell of *Sagartia venusta*, with the barbed thread emitted.
Fig. 8. Thread-cell of the same, before emission.
Fig. 9. The same, with the unbarbed thread.
Fig. 10. Thread-cell and thread of *S. Bellis*.
Fig. 11. Thread-cell and thread of *S. Troglodytes*.

N.B. All the thread-cells are magnified 560 diameters.

TAB. XXIX.

The Diagram above referred to.

P. H. Gosse Esq. del.

G. Jarman sc.

HYDRO-
IDA
ARACHNODERMATA
Bougainvillæa
ASTEROIDA
Lucer-
naria
Floscularia
ROTI-
FERA
Balano-
phyllia
regia
Caryo-
phyllia
Smithii
Anthea
Buno-
des
clavata
ZOAN-
THIDÆ
Actinia
can-
dida
bellis
dian-
thus
Sagartia
para-
sitica
rosea
viduata
Adam-
sia
Capnea
Coryn-
actis
Ilyanthus
Edwardsia
Peachia
Chirodota
ECHINODERMATA

XXXI. Horæ Carcinologicæ, *or Notices of Crustacea.* I. *A Monograph of the* Leucosiadæ, *with observations on the relations, structure, habits and distribution of the family; a revision of the generic characters; and descriptions of new genera and species.* *By* Thomas Bell, *Esq., V.P.R.S., Pres. L.S. &c.*

Read June 5th, 1855.

THERE is not perhaps another family amongst the whole of the *Decapodous Crustacea* so distinctly isolated by its general characters as the Leucosiadæ. Belonging, as they obviously do, to the large tribe of *Oxystomata*, to which they are allied by the important character of the form of the buccal cavity and the structure of the foot-jaws, they have in many respects but little tangible affinity with any other family of that group, by means of intermediate aberrant forms, with the exception of a certain *primâ facie* approach to the *Calappadæ* in the genus *Oreophorus*, to which further allusion will be made.

And not only is there such a remarkable absence of any osculant form within the limits of this very natural group, but there is a no less striking want of any obvious approximation to this type in the other families of the *Oxystomata*; for the relation suggested by De Haan of the genus *Matuta*, or rather his family of *Matutoidea* comprising *Matuta* and *Hepatus*, as leading to the *Leucosiadæ*, appears to me quite devoid of any sound foundation. Still less appearance is there of any important approximation to the *Raninadæ*, as suggested by the same learned writer.

I cannot, however, but believe that there is a structural approach to this family in a genus which has hitherto been placed at a remote distance from it by all the authorities on this subject, and particularly by Professor Milne-Edwards in his recent admirable treatise, as it may be called, on the *Catametopa*. I allude to the genus *Pinnotheres*, which in the work above mentioned is associated with the families *Grapsidæ*, *Gecarcinidæ*, *Ocypodidæ*, &c., to which groups its affinity is probably much more slight than to the family now under consideration. It will be reserved for a future occasion to examine into the real relations of the somewhat anomalous family of the *Pinnotheridæ*; but I would observe, that the general aspect of the male *Pinnotheres* is so similar to that of a true *Leucosia* as to be obvious at the first glance; and although I would not trust too much to external form and general character or aspect, I think these points may be, and often are, underrated. There is frequently a physiognomical character, so to speak, which is indicative of some close relation of affinity, which ought not to be cast aside hastily and without due consideration as a mere analogical resemblance. I shall not on the present occasion enter into a detailed investigation of the relation between these two types, but I may observe that the form of the buccal opening, the foot-jaws, the eyes, the antennæ and other important organs appear to me to afford indisputable indications of the affinity in question.

The approach of the genus *Oreophorus* to the *Calappadæ* is, however, more apparent,

and in all probability constitutes a true relation of affinity. This remarkable genus was first formed by Dr. Rüppell, who figures and describes a species, *O. horridus**, found by him in the Red Sea. It is evidently constructed on a type approximate to the *Calappadæ*. Like them it has the power of concealing the feet under the body, so that when at rest they are protected by the margin of the carapace, which is somewhat dilated laterally. In this particular it resembles *Æthra*, as well as *Cryptopodia*, *Lambrus* and others, with which it has however no other near structural relation. The genus *Nursia* of Leach, and the new genus *Lithadia*, which is closely allied to *Ebalia*, approach it in a slight degree in this respect, and the latter still more in its general aspect and the extreme rugosity of the body.

The tendency to a lateral dilatation of the carapace is indeed a very striking character in several forms of this family. It has been already alluded to in reference to *Oreophorus* and *Lithadia*: it appears also to a certain extent in *Phlyxia* and *Ebalia*. But in *Iphis* it assumes a very different form, terminating in a long acute spine on each side, recalling in some measure the aspect of the genus *Matuta*; whilst in *Ixa* a still more remarkable development is observed in an extraordinary lateral extension of the carapace itself, which is twice as broad as it is long, besides its still further production into a somewhat cylindrical process on each side, the two processes together constituting about half the total breadth.

The characters of a group so distinctly marked could not fail to strike the accurate and observant mind of Fabricius, who, in the course of his re-formation of the whole class, brought together all the species which were then known of the *Leucosiadæ* into a single genus, to which he gave the name of *Leucosia*. This name was retained by Leach for the form which is evidently the typical one; and he arranged into several well-defined generic groups the species thus associated by his predecessor, together with others with which he had become acquainted. All Leach's generic divisions have received the sanction of subsequent naturalists; and the only changes which have been introduced since his time have consisted in the discovery of some new species†, if we except the mistaken application, by Milne-Edwards, of the name of *Guaia* to certain species which Leach had already designated under the generic appellation of *Persephona*. This mistake however was a very natural one, arising from the vague and brief terms in which Leach had indicated rather than described or defined them. The specific and even the generic characters given by this distinguished naturalist are often, from an inordinate desire for brevity, extremely vague and incomplete; and now that the number of known species and of generic forms has become so immensely increased, it is often in vain that we endeavour to reduce to any certainty the contracted and indefinite phraseology in which his characters are expressed.

It is clearly of the greatest importance not only that the distinctive phrase applied to

* Krabben der Rothen Meeres, p. 18. t. 4. f. 5.

† *Harrovia* and *Tlos*, genera described by Adams and White in the "*Crustacea*" of the Voyage of the Samarang, and placed among the *Leucosiadæ* in that work, certainly do not belong to this family. *Iphiculus* is stated by those authors to belong to the *Parthenopidæ*, although located in their work with the *Leucosiadæ*; but as regards this genus, I am led, by examination of the specimens in the British Museum, to the conviction that it is in truth a Leucosian genus, and that they are right in the text and not in the note.

a species should be as tangible and certain as possible, but that every new species should be fully, as well as accurately described in detail. In this respect Leach was generally very deficient. The only indications left of many of his species and even genera, consist of half-a-dozen words, in many instances so vague that they have become useless, and, as they are often not illustrated by figures, it would be impossible to identify the species to which they refer, were it not for the existence of the specimens themselves in the British Museum. This is particularly the case in respect to the present family, of which Leach gives many new genera and species in his valuable repertory the 'Zoological Miscellany;' but in so slight a manner that only the tickets applied to the specimens in the Museum by Leach himself afford any sure index to the species intended.

This however is not the only fault to which naturalists are prone with regard to the definition or description of new species. Nothing is more common than that the only characters given are deduced from a comparison of the development of certain organs with the same parts in nearly allied species. Such specific characters are always objectionable. To describe an organ in one species as longer or broader or thicker than the corresponding organ in another species for instance, infers the necessity of an actual comparison of one with the other, which, of course, is often impossible. Specific distinctive characters should always be either absolute, or derived from points of comparison within the individual itself. Another defect from which much confusion has arisen, is the want of a full detailed *description* of each species, which is necessary, however nearly it may be allied to another; and this should include every organ of importance that can be easily and certainly brought under review. The want of this desideratum has been the fruitful source of errors in synonymy, and the cause of interminable and unsatisfactory research and labour. I may be allowed to add, that the *specific definitive phrase* should be such as to point out, as briefly as may consist with clearness and certainty, the points of distinction from all those already known in the same genus; whilst the *description* should be so full as to enable the naturalist to ascertain whether any individual afterwards observed is a new species, or identical with that described.

The admirable work of Professor Milne-Edwards, which has been the text-book of every student of this class of animals ever since its publication, contains such a general view of their organization as renders it unnecessary for me to enter into any considerable detail of their structure, particularly as that work is in the hands of every one interested in this subject. But in the fine work of De Haan on the *Crustacea* of Japan, there occurs so concise and clear a summary of the characters of those organs on which the classification depends, that I will venture to quote the passage at length :—

"Regiones pterygostomianæ supra palpos maxillarum quintarum excavatæ, extrorsùm marginatæ, excavatione parallelâ usque ad oris apicem productâ; maxillarum quintarum articuli secundi et tertii ter longiores quam lati[ores], triangulum describentes, margine interno sunt obtusi; maxillarum quintarum laciniæ externæ maxillis quintis æquales et palporum flagella tenuissima; maxillæ secundæ minimæ, laciniis externis cum palpis coalitis, et setis duabus a sibi invicem apice distinctis; sella turcica brevissima vel nulla; apodemata sterno intermedio distantia; branchiæ sex, nulla maxillis, unica pedibus tertiis;

pedes in eodem plano inserti; orificia generationis masculina in sterno locata, fœminina in medio articulo tertio sterni; abdomen arctè cum sterno cohærens, operculiforme, in maribus 4- vel 5-, in fœminis 5-articulatum; abdominis articuli primi organa vaginæformia recta vel spiralia basi sejuncta in *Leucosiis*, vel compressa basi conjuncta in *Iliis*; organa excitantia articuli secundi, aut tertiam partem anteriorum æquant in *Leucosiis*, aut planè desiderantur in *Iliis* et *Philyris*; appendices abdominales fœminarum externæ oblongæ foliaceæ et internæ setaceæ sub angulo recto geniculatæ."

I will now offer a few general remarks which may illustrate the bearing of their structure upon their habits. This structure is evidently not fitted for any rapid or energetic movements such as belong to the *Grapsidæ* and *Ocypodidæ*, in which these powers are amply provided for by the robust form and development of the ambulatory pairs of legs; nor does it afford any means of swimming, as in the *Portunidæ*, or still more in *Matuta*; nor is it fossorial, as in *Carcinus* and many others; nor suited for climbing, as in the long slender-legged *Leptopodiadæ*; nor for self-concealment, as in the *Calappadæ*. It appears that they must depend for their safety from external injury upon the protection of stones and the hollows of rocks; for their claws have no power of defence, and the ambulatory legs are comparatively slender and ineffective. The carapace in most of them however is remarkably hard, and its arched form gives it additional power of resistance.

The extreme minuteness of the eyes would agree with the idea of their lurking and somewhat stationary habits; and this, with the almost rudimentary form of the antennæ, appears quite inconsistent with any high development of the functions of relation. In entire agreement with the view I have taken of the slow and feeble movements of these animals, as deduced from a consideration of the structure of the organs of locomotion, is the diminished extent of their respiration, evinced by the reduction of the number of their branchiæ to six pairs, whilst the foot-jaws and other manducatory organs are also small and weak.

Of the habits of most of the animals of this family we have no recorded history; but the account which that excellent observer Roux has given of the species of *Ilia* as noticed by himself on the shores of the Mediterranean, is in exact accordance with the structure I have described, and the functions which have been predicated from that structure. Speaking of this genus, he says*, "Les *Ilia* ont le têt très dur; ce sont des Crustacés qui vivent solitaires, cramponnés parmi les Flustres et les Madrépores, ou sur les écueils, à de moyennes profondeurs; leur marche est lente; ils manquent d'agilité; la forme de leur corps et la débilité de leurs pattes s'opposent à ce qu'ils puissent nager; on ne les voit courir qu'à l'aspect du danger." And of *I. nucleus* he says, "Ce décapode est extrèmement timide; il habite les moyennes profondeurs coralligènes, d'où il ne sort que lorsque le hasard lui présente quelque proie facile à saisir. Il ne s'approche jamais des rochers du rivage. On le rencontre rarement parmi les algues, si ce n'est en Mars, époque à laquelle la femelle vient quelquefois y déposer des œufs qui éclosent en été."

The geographical distribution of the *Leucosiadæ* is as remarkable for the restriction of the genera of which it is composed to special localities, as is the whole family with respect to its zoological relations, which have already been considered. Every genus, without

* 'Crustacés de la Méditerranée.'

exception, is restricted to its own geographical limit. There is not, I believe, a single instance of one species of any genus inhabiting the Old World, and another of the same genus being found in the New. The numerous species of what may be considered the typical form of the family, *Leucosia*, are without exception inhabitants of the Eastern seas, ranging from the south of Australia by the Indian Ocean, the Philippines, New Guinea, Borneo, the coasts of China and Japan; but strictly circumscribed to these limits. The genera *Myra*, *Philyra*, *Myrodes*, *Platebalia*, *Ixa*, *Iphis*, *Iphiculus*, and *Arcania* are also confined to the same seas. Of *Oreophorus* one species is found in the Red Sea, and the other has been taken in the Straits of Sunda. *Ebalia* is, as far as we are at present informed, confined to the tract including the coasts of Great Britain, "La Manche," and the Mediterranean; and so much is it especially a British genus, that Professor Milne-Edwards, when he published his great work, had never seen a specimen of either of the three generally known species, excepting those in the British Museum, all of which were natives of this country; nor does he mention a specimen of either of them as then existing in the Paris Museum. *Ilia* is exclusively Mediterranean. The numerous species of *Persephona*, and the new genera *Leucosilia* and *Lithadia*, are strictly American, and are principally found on the Eastern coasts and the Galapagos Islands.

The majority of the species in this family are found at no great depth.

I know of scarcely any family of *Crustacea*, our knowledge of the species of which has so much increased of late years as this. When the great text-book of the class, the admirable work of Milne-Edwards, appeared, there were only known to him twenty certain species arranged in eleven genera. The great work of De Haan on the *Crustacea* of Japan added several others, and the list has been increased by Messrs. Adams and White in their description of the *Crustacea* from the voyage of the Samarang. The collections made by Mr. Cuming in the Philippine Islands and by other voyagers, have placed within my reach numerous others, some of which are in my own collection, but the greater number are in the British Museum; and I have to express my thanks to Mr. Adam White for the exercise of his well-known courtesy and attention in assisting my access to the treasures of that fine collection. In the present Monograph I have been enabled to add no less than thirty-six new species, thus more than doubling the number previously known; the whole number now known and included in the present Monograph being sixty-five, constituting eighteen genera.

Genus Leucosia.

Char. Gen.—*Testa* ovato-orbicularis, subglobosa, lævis, polita; fronte subproducto, fossulas antennarias tegente. *Orbita* fissuris tribus. *Fossæ antennariæ* obliquæ, apertæ. *Pedipalpi externi* caule exteriore lateribus parallelis, recto vel subcurvo, apice obtuso; caule interiore acutè triangulari. *Pedes antici* crassiores, longitudine mediocres; brachiis ad basin et ad latera tuberculatis; digitis tenuibus subinflectis; *pedum paria quatuor posteriora*, a secundo ad quintum sensìm breviora. *Abdomen* Maris in nonnullis speciebus segmentis omnibus, primo et ultimo exceptis, in aliis tertio cum quarto, et quinto cum sexto—Fœminæ a tertio ad sextum coalitis.

The genus *Leucosia* must be considered as the type of the family; and, as is often, perhaps generally, the case with a typical genus, it includes a much larger number of

species than any other. Its characters are so defined, that none of the species exhibit any approximation to another generic form. The genera *Myra* and *Persephona*, and *Ilia* and *Leucosilia*, have so much that is common to them all in their structure and general aspect, that it requires close examination to determine their limits; but in *Leucosia*, numerous as the species are, not only the essential characters of the parts on which the generic distinction usually depends, but also the general features of the whole form, are remarkably similar in all the species, and obviously distinct from all others.

There are indeed in this genus many interesting points in the general form and colour and other less essential characters, which although not of much physiological or functional import, are curious as exhibiting coincidences which in many cases serve to indicate a close relationship as strongly as those modifications of organs and functions which have a more important bearing upon the habits of the species, and are commonly considered as essential. The polished carapace;—the absence of all hairiness or other clothing, which is universal, with the exception of two species, *L. Whitei* and *unidentata*, in which a small quantity of close hair exists amongst the tubercles of the arms;—the existence of large and distinct granulations, or rather tubercles, generally distinctly coloured, upon at least the proximal part of the arm, extending forward in lines more or less numerous;—the tendency to a brown or purplish-brown colour in most of the species;—and the occurrence, in very many, of spots occupying the same situation on the carapace, four of which are paler than the ground colour, and placed at the anterior part on the gastric region, and two dark ones upon the posterior portion of the branchial;—these are amongst the characters of minor consequence to which I have alluded, and which, without having any bearing upon function or habit, are interesting from the constancy or frequency of their occurrence, and as indicative of certain structural or formal tendencies throughout the whole genus.

There is also one remarkable peculiarity which exists in almost all the species of *Leucosia*, but I believe in no other genus, the variations of which constitute good specific characters. This is a sinuous groove running along the side of the thorax, bounded above by the lateral margin of the carapace, and beneath by the upper edge of the epimeral plate; the former loses itself in the posterior part of the branchial region, the latter is continued into the posterior margin of the carapace. It commences in front of the first pair of legs, where it forms a single or double notch, or a deep, almost circular cavity. Its margins are usually tuberculated, and the tubercles are ordinarily largest at the anterior part. A very few species, as for instance *L. orbicularis*, have no such groove, the epimeral piece or space between the lateral margin and the junction of the carapace with the sternum being plain and smooth. De Haan is the only author who has noticed this curious structure, and he has only mentioned its anterior limit, which he terms "*incisio ante chelarum insertionem*." This expression, however, gives no idea of its true extent or course; and I have called it "*sinus thoracicus*," as more expressive of its character, and more easily available in specific description. Of its use I can offer no suggestion. It does not appear to have any connexion with the interior of the body, nor can it be supposed to have any important office, as in some species it does not exist.

In the year 1837, when Professor Milne-Edwards published his 'Histoire Naturelle des Crustacés,' two species only of this genus were distinguished, *L. Urania* and *craniolaris*.

These were both known to the earlier naturalists. One of them is figured by Rumphius and Seba, and both by Herbst in his great repertory of crustacean animals. Fabricius, Lichtenstein, Leach, Desmarest, and others down to Edwards, have restricted their notice to these two species. De Haan, in his admirable work on the Crustacea of Japan, forming a portion of the great work of Siebold, adds four species, and Messrs. Adams and White have described a seventh in the Voyage of the Samarang. The additions, however, which have recently been made to the carcinology of the Eastern Seas by Hinds, Macgillivray and others, and especially by Mr. Cuming in his Philippine voyage, have enabled me to swell the list of distinct species to no fewer than twenty.

LEUCOSIA URANIA, Herbst. Testâ subglobosâ, anticè productâ, fronte rotundato; brachiis triedris, suprà ad basin tuberculis paucis; sinu thoracico usque ad latera regionis hepaticæ anticè attingente, granis suprà marginato.

Rumph. t. 10. f. A. B. Seba, iii. t. 19. f. 4, 5.

Cancer Urania, Herbst, iii. t. 53. f. 3.

Leucosia Urania, Leach, Zool. Misc. iii. p. 21. Edw. Règ. Anim. de Cuv., Crust. t. 25. f. 2; Hist. Nat. des Crust. ii. p. 122.

Hab. Maria orientalia. Muss. Brit., Bell.

The colouring of this species is remarkable. Of a general pale brownish-grey; the front, and a large mark proceeding backwards from it are white; two large spots on the posterior part of the carapace, and two smaller ones on each lateral margin, the articulations of the fore legs, the basal portion of the fingers, and a ring on each joint of the ambulatory feet, are all of a more or less deep orange colour*.

Specimens of the species are not unfrequently brought with other objects from China, and these are almost always deprived of the abdomen, for the purpose of cleaning the interior.

The tubercles on the arms are disposed in a remarkable manner. On the upper side near the base there is a congeries of about five or six small ones, and immediately in front of them four large ones disposed in a quadrate form. On each margin there is a series of tubercles, which are large near the base, diminishing forwards. The anterior portion of the three sides is free from tubercles, excepting on the margins.

LEUCOSIA CRANIOLARIS, Linn. Testâ rhomboideâ, fronte tridentato; brachiis serie tuberculorum ad latera, et tuberculis duobus tantùm suprà ad basin.

Cancer craniolaris, Linn. Mus. Lud. Ulr. p. 431. Herbst, t. 2. f. 17.

Leucosia craniolaris, Fabr. Supp. p. 350. Leach, Zool. Misc. iii. p. 21. Edw. Hist. Nat. des Crust. ii. p. 122.

Hab. ad oras maris orientalis. Muss. Brit., Soc. Linn., Bell.

This well-known species is easily distinguished from every other by the paucity of the tubercles on the arm. The three sides are bordered, as in other species, with a series of tubercles, but there are no others, excepting two above and about the same number beneath, at the base. The carapace is remarkably rhomboidal, the front tridentate, the

* There are specimens in the British Museum in which this colouring is not distinct, but these are probably bleached.

middle tooth being longer than the lateral; the thoracic sinus terminates anteriorly in a notch, which reaches upwards to the margin of the carapace between the hepatic and branchial regions. The abdomen is long, lanceolate, and slightly hastate at the base. This is one of the two species so often figured and described, and the only ones known until within the last few years. It is very probably the *Cancer craniolaris* of Linnæus, and certainly that figured under this name by Herbst; it is the *Leucosia craniolaris* of Fabricius and all subsequent authors. There are several specimens in the British Museum, in the Banksian Collection of the Linnean Society, and in my own collection. It inhabits the Eastern Seas, being found on the coast of China, &c.

There are several other species which resemble it in some degree in general form and proportions, but the paucity of tubercles on the arm sufficiently distinguishes it from them all, excepting *L. rhomboidalis* of De Haan, which is certainly very nearly allied to it, but differs in the hairy surface of the arms.

Leucosia obtusifrons, De Haan. Fronte rotundato; sinu thoracico anticè circulari, tuberculis circumscripto; brachiis ad latera et ad basin tuberculatis; manibus longioribus quam latioribus, serie granulorum ad marginem interiorem.

De Haan, Crust. Japon. p. 133. t. 33. f. 2.

Hab. ad ins. Japoniam. Mus. Brit.

Leucosia unidentata, De Haan. Fronte unidentato; sinu thoracico anticè circulari, tuberculis perlatis circumscripto; brachiis facie superiore seriebus binis tuberculorum.

De Haan, Crust. Japon. p. 133. t. 33. f. 3.

Hab. Japonia, ins. Moluccenses, &c. Muss. Brit., Bell.

Leucosia rhomboidalis, De Haan. Testâ rhomboidali, anticè productâ, multò longiore quam latiore; brachiis basi utrinque densè tomentosis, lateribus tuberculatis, suprà plerumque lævibus.

De Haan, Crust. Japon. p. 132. t. 33. f. 5.

Hab. ——? Mus. Brit.

Leucosia longifrons, De Haan. Testâ subglobosâ, fronte producto, integerrimo; sinu thoracico anticè elliptico, granis non cincto; brachiis lateribus tuberculatis et granulis paucis ad basin.

De Haan, Crust. Japon. p. 132. t. 33. f. 4.

Hab. ——? Mus. Brit.

Leucosia orbicularis, mihi (Tab. XXX. fig. 1). Testâ orbiculari, fronte lato, brevissimo, bidentato; sinu thoracico nullo; sterno in utroque sexu anticè granulato.

Hab. ad oras Australiæ. Muss. Brit., Bell.

The carapace in this species offers the nearest approach to the orbicular form of any of the genus. The front remarkably broad, scarcely projecting, and slightly bidentate; hepatic region not distinct; marginal line nearly smooth anteriorly, the marginal granulations becoming conspicuous over the branchial region, and continued in an uninterrupted

line around the posterior margin. There is no trace of the thoracic sinus. External foot-jaws extending quite to the extremity of the front, the anterior portion slightly granulated, and the external stalk (palp) with the margin slightly curved. The sternum in each sex is bordered anteriorly with a line of distinct granulations. Abdomen of the male with the sides parallel to within one-third of the extremity, the remainder triangular, with a strong projecting tooth. The anterior legs twice as long as the breadth of the carapace; the arm above covered with granulations for about half its length, the remainder quite smooth; wrist rounded, perfectly smooth; hand half as long again as it is broad, slightly flattened, without any carina or granulations; the fingers long, curved, meeting only at the points, and furnished with a few distant teeth.

Length of the carapace 0·9 in.

Several specimens of this species from Australia exist in my own collection and in the British Museum.

LEUCOSIA PALLIDA, mihi (TAB. XXX. fig. 2). Fronte tridentato, ultra orbitâ producto; sinu thoracico in sulco brevi profundo anticè terminato, granulis paucis supra insertionem pedum anteriorum; manibus utrinque subcarinatis omninò lævibus; digitis inermibus.

Hab. in mari orientali. Mus. Brit.

Carapace contracted anteriorly, rounded and very convex behind; front tridentate, projecting beyond the orbits; latero-anterior margin waved, granulated; hepatic region slightly elevated; posterior margin projecting; thoracic sinus terminating anteriorly in a deep hollow, in which are a few large granulations just above the insertion of the anterior legs. Abdomen as in *L. affinis*. External pedipalp smooth in the male; a slight projection on the middle of the inner stalk in some females. Anterior legs of moderate length; arm granulated on the upper surface, excepting an oval space on the distal third of its length; the under surface with all the middle and anterior portion smooth; wrist small, rounded, and smooth; hand longer than it is broad, slightly carinated on each side, without any granulations; fingers meeting at the anterior third of their length, without any teeth or tubercles.

Colour pale grey, marbled with a somewhat darker hue; four whitish spots on the anterior part of the carapace, and two dark ones behind.

Length of carapace 0·8 in.

Several specimens of this pretty species are in the British Museum, obtained from the Voyage of the Samarang.

In general colour it is very different from any other; but it has the four anterior pale and the two posterior dark spots which prevail so remarkably in this genus.

LEUCOSIA OBSCURA, mihi (TAB. XXX. fig. 3). Testâ suborbiculari, rostro ultra orbitâ producto, minutè tridentato; sinu thoracico angustissimo; manibus longioribus quam latioribus, utrinque carinatis, non granulatis; digitis inermibus.

Hab. ad insulas Philippinas. Muss. Brit., Bell.

Carapace suborbicular, front tridentate, the middle tooth the longest; margin granu-

lated, latero-anterior portion slightly waved, posterior margin a little projecting. Thoracic sinus deep, very narrow, terminating anteriorly in a narrow double notch, which is furnished beneath with a few large granulations. External pedipalps in the male quite smooth; in the female the stalk has the basal half much raised; the inner edge hairy. Anterior legs rather longer than the carapace; the arm granulated above, excepting the anterior tubercle; wrist smooth; hand longer than broad, carinated on each side, wholly without granulations, fingers meeting only at the points, without teeth or tubercles, the fifth pair with the penultimate joint as broad as it is long. Abdomen in the male with two rounded smooth elevations at the base, narrowest towards the centre; in the female broad oval, widened towards the anterior part.

Length of the carapace 0·9 in.

Colour rich brown above, the two posterior spots darker; light brown beneath.

Several specimens in the British Museum and in my own collection were brought from the Philippines by Mr. Cuming.

Leucosia marmorea, mihi (Tab. XXX. fig. 4). Testâ longiore quam latiore, maculis sex albidis; sinu thoracico anticè brevi, lineâ semicirculari granulatâ terminato; fronte minutè tridentato, dente medio longiore; brachiis ad basin et ad latera tuberculatis; manibus margine interno granulato, externo rotundato.

Hab. ad insulas Philippinas. Mus. Brit.

Carapace longer than broad by the whole length of the front, somewhat narrowed forwards, the latero-anterior margin nearly straight; hepatic region with a slight elevation; thoracic sinus deep, extending forwards very little in advance of the insertion of the anterior feet, and bounded by a semicircular granulated margin. Marginal granulations of the carapace extremely small and not contiguous at the anterior part, gradually enlarging and becoming flattened backwards. Front minutely tridentate, the middle tooth the longest. External foot-jaws smooth, polished, with a line of minute impressed dots near the margin. Anterior legs robust; arm on the upper side with a line of large granulations on the outer and inner margins, a few on the proximal portion, and two or three only extending forwards, the rest of the upper surface smooth; the under side with a line of similar granulations on the inner margin. Wrist smooth, rounded, with a line of minute granulations on the inner side; hand rather longer than broad, somewhat tumid in the middle, flattened towards the edges, the inner edge with a line of small granulations, the outer smooth and rounded; fingers meeting only at their points, armed with distant tubercles, and having a wide space near the joint. Abdomen (male) broad at the base, then with the sides parallel, the penultimate segment rounded at the anterior margin, and armed with a strong straight pointed tooth.

Colour rich yellowish-brown.

Length of carapace 1·4 in.

Leucosia punctata, mihi (Tab. XXX. fig. 5). Testâ impresso-punctatâ, fronte producto, subemarginato; brachiis suprà omninò granulatis.

Hab. in Mari Indico. Mus. Brit.

Carapace somewhat rhomboid, rounded at the posterior margin; the front projecting beyond the orbits, slightly emarginate; hepatic region with a slight central elevation; thoracic sinus terminating anteriorly in a notch bordered with large granulations; lateral margin strongly granulated. External foot-jaws flat, smooth, with the outer margin straight. Anterior margin of the sternum granulated. Anterior pair of legs nearly twice as long as the postfrontal portion of the carapace; the arm long, with three series of larger granulations on the upper side, extending to about two-thirds of its length, the remaining portion entirely covered with smaller ones; the wrist somewhat triangular, longer than it is broad, slightly granulated above and at the sides; hand somewhat tumid in the centre, slightly carinated on each side, the inner only granulated; fingers touching only at the point, with a large interval at the base. Abdomen (male) broadest at the base, where it is furnished with two large oval protuberances; the penultimate segment oval, with its posterior margin truncate.

Length of carapace 0·8 in.

Colour greyish-brown, with two darker spots on the branchial regions.

This species, of which a single specimen exists in the British Museum, differs from all others that I am acquainted with in the very distinct punctuation of the whole surface of the carapace. The arm also is covered with minute granulations at the anterior portion, which in most species is quite smooth. In other respects it very much resembles the following species, *L. affinis*. Its habitat is not absolutely known, but it is in all probability from the Indian Ocean.

Leucosia affinis, mihi (Tab. XXX. fig. 6). Testâ anticè angustatâ, fronte valdè producto, subemarginato; manibus longioribus quam latioribus, utrinque carinatis; brachiis anticè tumidis, lævissimis, politis.

Hab. ad insulas Philippinas. ♂ Mus. Bell.

Carapace somewhat rhomboid, narrowed anteriorly, with a few scattered punctures; the front much produced, with a triangular elevation extending backwards, and a depression on each side of the front, the extremity slightly emarginate, and extending beyond the orbits. The thoracic sinus short, extending backwards but little beyond the insertion of the anterior legs, terminating in front in a granulated notch. Anterior legs rather long, the arm above with about three series of granulations, which are larger at the base, becoming smaller forwards, the distal portion tumid, polished and free from granulations, excepting at the inner margin; the wrist rounded, with a single row of small regular granulations on the inner side; hand longer than broad, carinated on each side, the inner with a granulated area, bordered with large granulations; fingers meeting only at the point. Foot-jaws and abdomen as in *L. punctata*.

Length of carapace 0·7 in.

This species greatly resembles the former in most of its characters; it is however easily distinguished by the almost total absence of punctures on the carapace, and especially by the naked polished area on the distal portion of the arm.

A single specimen (male) is in my collection, received from Mr. Cuming.

Leucosia brevimana, mihi (Tab. XXX. fig. 7). Testâ subrhomboidali, fronte emarginato, margine laterali vix granulato; manibus æquè longis ac latis, internè subcarinatis, lævibus.

Hab. ad insulas Philippinas. Mus. Bell.

Carapace somewhat rhomboidal, rounded behind; front rather prominent, slightly emarginate; lateral margin scarcely granulated; thoracic sinus deep, narrow, extending back to the posterior part of the branchial region, its inferior boundary granulated, and continued into the posterior margin. External foot-jaws with the stalk longitudinally convex. Arms with the upper side bordered by a row of large tubercles on each side, and an intermediate one, consisting of not more than three or four at the base, the inner side presenting a smooth triangular area bounded by large tubercles; wrists smooth, short and small; hands as broad as long, smooth, slightly carinated on the inner side; fingers as long as the hand, the moveable one rather the longer. Abdomen (female) broad oval, the first and second joints with a broad carina in the middle.

Colour brownish-grey.

Length of carapace 0·8 in.

Brought from the Philippines by Mr. Cuming.

Distinguished from most other species by the absence of conspicuous granulations on the lateral margin of the carapace, by the equal length and breadth of the hands, and by the paucity of tubercles at the base of the arm.

A single female specimen is in my collection.

Leucosia margaritacea, mihi (Tab. XXX. fig. 8). Testâ multò longiore quam latiore, lævissimâ, margaritaceâ; sinu thoracico margine lævi; brachiis suprà tuberculis albis, rubro cinctis.

Hab. in Oceano orientali. Mus. Brit.

Carapace about one-fifth longer than it is broad, somewhat rhomboidal (much resembling *L. punctata* and *affinis* in general form), extremely smooth and polished, and of a pearly lustre; front prominent, obtuse; thoracic sinus short, deep, with the margins not granulated; pedipalps and sternum smooth; arms covered, excepting at the distal extremity, with large granulations, which are ocellated, being white in the centre, surrounded by a red ring; wrist rounded, and wholly smooth; hands longer than they are broad, granulated only along the inner margin. Abdomen similar to that in *L. punctata* and *affinis*.

Length of the carapace 0·7 in.

A single specimen, probably from the Indian Ocean, is in the British Museum.

This species exceedingly resembles *L. punctata* and *affinis*. From the former it may be at once distinguished by the absence of all punctures on the surface of the carapace, and from both by the absence of granulations on the margins of the thoracic sinus, and by the red and white ocellated tubercles on the arm. The pearly glance on the whole surface of the carapace is peculiar to this species, and appears not to depend upon any change from external causes.

LEUCOSIA OCELLATA, mihi (TAB. XXXI. fig. 1). Testâ rhomboidali, fronte tridentato; regione gastricâ maculis quatuor parvis rubris signatâ, quarum binæ anteriores ocellatæ.

Hab. ad oras orientales Australiæ. Mus. Brit.

Carapace rhomboidal, nearly as broad as it is long; front tridentate; margin granulated, excepting anterior to the hepatic region, latero-anterior margin waved; thoracic sinus deep, extending to the fifth pair of legs; the four spots on the gastric region, which are in other species large and pale, replaced by very small red ones, of which the anterior pair are distinctly ocellated. Sternum and pedipalps smooth. Buccal opening very broad at the posterior part, becoming regularly narrowed forwards, forming nearly an equilateral triangle. Anterior legs stout; arm covered, excepting on the anterior part, with four rows of tubercles, each of which is white in the centre, surrounded with a red ring; wrist rounded, with a line of inconspicuous granules on the inner side. Hand rather longer than broad; the inner margin granulated; fingers meeting only at the point; the four posterior pairs of legs with the joints tumid.

Length of carapace 0·7 in.

The four red spots on the carapace, of which the anterior pair are distinctly ocellated, will at once distinguish this species from every other; and it is remarkable that a similar disposition to ocellation is observable in the colour of the tubercles on the arms.

LEUCOSIA HÆMATOSTICTA, Adams and White. "Thorace trapezoidali, suprà valdè convexo, post angulum latero-anteriorem incisurâ profundâ, maculis multis sanguineis rotundatis obsito."

"*Hab.* Maria orientalia."

Adams and White, Zool. Voy. of the Samarang, p. 54. t. 12. f. 2.

Mus. Brit.

This is one of the most beautiful little species of the genus; and one of the most peculiar in its form and markings. I have taken the above characters from the work of Messrs. Adams and White, in which the species is prettily figured.

Length of the carapace 0·5 in.

LEUCOSIA WHITEI, mihi (TAB. XXXI. fig. 2). Testâ rhomboideâ, fronte producto, minutè tridentato; regionibus hepaticâ et branchiali granulis tribus vel quatuor; brachiis tomentosis, tuberculis magnis omninò instructis.

Hab. ad oras Australiæ. Mus. Brit.

Carapace rhomboid, nearly as broad as it is long; front distinct, produced, with three minute teeth; the hepatic region slightly raised, with three or four distinct granulations; the anterior portion of the branchial with the same number of similar ones near the margin; latero-anterior margin smooth; latero-posterior granulated, bordered above with a line of short woolly hair; thoracic sinus deep, strongly waved above, the inferior margin granulated, passing into the posterior marginal line, which is turned up, flattened and crenate. Eyes visible from above. External foot-jaws simple and smooth. Abdomen of the female broad oval, the division of the third, fourth and fifth segments indicated by grooves

interrupted in the middle. First pair of legs rather short and thick; the arm covered with distinct round tubercles, which are largest near the base, which part is slightly hairy between the tubercles; wrist granulated; hand tumid, scarcely longer than broad, with a slight granulated carina on the outer and inner margins; fingers flattened, carinated on the outer side, without perceptible tubercles or teeth, and meeting only at the points.

Length of the carapace 0·6 in.

Colour light brown; the spots on the carapace small, of an angular form, and red colour; a large red spot on the upper surface of the hand.

A single female specimen was found by Mr. Macgillivray on the eastern coast of Australia.

This is a very remarkable species, not only from its general form and character, but particularly as being almost the only one of the genus which exhibits the slightest appearance of hairiness or clothing of any kind.

Leucosia Cumingii, mihi (Tab. XXXI. fig. 3). Testâ suborbiculari, margine lævi; sinu thoracico incisurâ inter regiones hepaticam et branchialem anticè terminato; regionibus branchialibus valdè tumidis.

Hab. ad insulas Philippinas. Mus. Brit.

Carapace suborbicular, of equal length and breadth; the margin rounded, not granulated; front obtuse, rounded; thoracic sinus deep, terminating anteriorly in a deep notch, corresponding with an incision in the margin between the hepatic and branchial regions; the latter region very tumid. Pedipalps rather broad, the outer margin slightly curved. Anterior legs stout, the arm short, with tubercles at the base and sides, beneath with a triangular area smooth; wrist rounded; hand nearly as broad as it is long, slightly carinated at the sides; fingers meeting only at the points, the moveable one grooved longitudinally.

Length of carapace 0·5 in.

Colour; the carapace pale yellowish-white, with yellow markings. The fingers marked with a transverse brown fascia; the hand with a small brown spot near the articulation of the moveable finger; and the abdomen with orange-coloured spots on the anterior part.

One of the most remarkable of the genus, and distinguished at once by the deep notch behind the hepatic region and the swollen form of the branchial.

Leucosia pulchella, mihi (Tab. XXXI. fig. 4). Testâ æquè longâ ac latâ, margine laterali lævi, tenui, subreflexo; brachiis suprà et infrà omninò tuberculatis; pedipalpis externis anticè paulò angustatis.

Hab. in mari Sinensi. Mus. Brit.

Carapace rhomboidal, as broad as it is long, the lateral margin without granulations, thin, expanded and slightly reflexed; thoracic sinus narrow, without granulations; front obtuse, either slightly emarginate or rounded. External foot-jaws nearly as broad at the apex as at the base. Anterior legs rather short; the arm entirely covered with tubercles above and underneath; wrist subglobose, with a few granulations at the inner side; hand

as broad as it is long, acutely carinated on each side, tumid in the centre; fingers flattened, triangular. Abdomen (male) broadly triangular.

Colour buff and white, beautifully mottled in some specimens, in one elegantly reticulated.

Length of carapace 0·4 in.

Of this pretty little species there are three specimens in the British Museum, from the Chinese Seas. It is easily recognizable at first sight by the thin, somewhat reflexed, smooth margin of the carapace, and the wholly granulated surface of the arms, characters which I believe do not exist in any other species of the genus. The buccal opening, and consequently the external foot-jaws, are remarkably broad anteriorly.

LEUCOSIA PHYLLOCHEIRA, mihi (TAB. XXXI. fig. 5). Manibus latioribus quam longioribus, utrinque lamellatis; pedibus omnibus posterioribus articulo penultimo lato, compresso, utrinque carinato.

Hab. ad insulam Borneo. Mus. Brit.

Carapace somewhat rhomboidal, as broad as the postfrontal portion is long; front very projecting, slightly emarginate, strongly carinated at the base, with a deep hollow on each side; thoracic sinus terminating in a marginal notch, above and in front of the insertion of the first pair of legs. External foot-jaws nearly half the length of the whole body. Anterior legs shorter than the carapace, the arm bordered with tubercles. Wrist small and rounded; hand broader than it is long, with a broad, flat, thin, laminated carina on each side; fingers rather broad, flattened, the immoveable one carinated beneath. The remaining feet with the fourth joint toothed along the under side, the fifth with a single tooth above, the penultimate short, flattened, and having a thin carina on each side, the terminal one lanceolate.

Length of carapace 0·4 in.

This is certainly the most extraordinary known species of *Leucosia*. The form of the legs, and particularly of the hands, which suggested the name, at once distinguishes it from all others; but the most remarkable anomaly in its structure is the extent of the buccal opening, and the corresponding development of the external foot-jaws, the length of which nearly equals that of the portion of the body posterior to them. This peculiarity will be appreciated when it is recollected that in the normal forms the relative proportion is not more than one in three. Whether this structure has any relation to the habits of the species, we have no means of ascertaining; but it would appear probable that such a marked anomaly could scarcely exist in mere obedience to those abstract laws of structural variation, which are often as difficult of solution as they are certain in fact.

A single male specimen from Borneo is in the British Museum.

Genus ILIA, Leach.

CHAR. GEN.—*Testa* subglobosa, posticè dentibus quatuor armata, quarum utrinque una compressa ad regionem intestinalem, et una conica ad branchialem; fronte bifido. *Orbita* suprà fissuris duabus. *Pedipalpi externi* caule exteriore recto, apice obtuso. *Pedes antici* longissimi, graciles, manibus contortis, antrorsùm angustatis.

Ilia Nucleus, Auct. Testâ minutè confertè granulosâ, granulis majoribus distantibus instructâ.

Cancer Nucleus, Linn. Syst. Nat. 1042. 20. Herbst, i. p. 87. t. 2. f. 14.
Leucosia Nucleus, Fabr. Suppl. p. 351. Latr. Hist. Nat. Crust. vi. p. 116.
Ilia Nucleus, Leach, Zool. Misc. iii. p. 24. Roux, Crust. de la Méditerr. t. 8. f. 1–8. Edw. Règ. Anim. de Cuv., Crust. t. 25. f. 2; Hist. Nat. Crust. ii. p. 124.
Hab. ad oras maris Mediterranei.

Ilia rugulosa, Roux. Testâ glabrâ, sparsim granulosâ, anticè lævi.

Ilia rugulosa, Roux, *l. c.* t. 8. f. 9–12. Edw. *l. c.* p. 125.
Hab. cum præcedente.

I refer to the admirable figures by Roux, in his 'Histoire des Crustacés de la Méditerranée,' for a clear exposition of the characters of these two species, the only ones of the genus yet known. I cannot believe that *Ilia punctata* of Edwards belongs to this genus at all. The figure in Herbst of *Cancer punctatus*, on which he has partly founded it, is undoubtedly that of a species of *Myra*, as is shown even by the form of the pedipalps, and it may possibly be that of *M. carinata* of this memoir. The species provisionally named *Ilia Mariannæ* by Herklotz, and figured by him from a specimen in the Louvain Museum, is obviously not an *Ilia*. The foot-jaws and abdomen it appears were wanting in the specimen, so that it would be difficult to state what may be its generic relation; but it has the appearance of *Myra*, or still more of *Myrodes*; or it may possibly offer a new generic type, as suggested by the author above-named.

Genus Persephona, Leach.

Char. Gen.—*Testa* ovalis vel orbicularis, depressa, dentibus tribus ad partem posteriorem armata, regionibus pterygostomianis angulatis. *Orbita* trifissa. *Fossæ antennariæ* transversæ. *Pedipalpi externi* caule exteriore paulo dilatato, sensim angustiore, ad apicem internè truncato. *Pedes antici* robusti, testâ haud bis longiores; *reliqui* articulis ultimo et penultimo compressis. *Abdomen* Maris segmentis a tertio ad quintum,—Fœminæ a quarto ad sextum coalitis.

The characters of this genus and those of the species named by Leach were so imperfectly given by him, in the 'Zoological Miscellany,' that Milne-Edwards, not having access to the specimens themselves from which they were derived, was fain to content himself with simply translating them, being wholly unaware that they referred to a previously well-known species, and in fact he gave to that species the generic name of *Guaia*. I have, I believe, been able successfully to unravel this complication by an examination of the numerous specimens in the British Museum, to which Leach's names were attached.

Persephona Guaia, Bell. Testâ ovatâ, sparsìm tuberculatâ, angulo pterygostomiano obtusissimo, spinâ mediâ posticâ lateralibus paulò altiore.

Cancer punctatus, Browne, Hist. Jamaica, i. t. 42. f. 3.
Cancrejo tortuga, Parra, Descrip. &c. t. 51. f. 2.
Cancer Mediterraneus, Herbst, ii. t. 37. f. 2.
Persephona Latreillii, Leach, Zool. Misc. iii. p. 22. Desmar. Cons. sur les Crust. p. 168.

Persephona Lamarckii, Leach, *l. c.* p. 23. Desmar. *l. c.* p. 168.
Guaia punctata, Edw. *l. c.* p. 127.
Hab. ad insulas Antillas.

After a careful collation of the specimens in the British Museum, I have found myself compelled to come to the conclusion, that all those which had been designated by Dr. Leach as of two distinct species, and named respectively *P. Latreillii* and *P. Lamarckii*, are in fact specifically identical. They vary only in a slight degree in the prominence of the angular ridge on the pterygostomian region; and even his own specific distinction goes no further than the meagre expression, in the one case, "angulis *subangulatìm* dilatatis," and in the other, "angulis anticis gradatìm et obtusè dilatatis." It appears that all the specimens which were in the collection at that period were entirely faded, so as to have lost that striking and beautiful marking which would have enabled him to identify them with Herbst's figure. Browne gives no indication of these markings, either in his figure or in the letter-press. It is also remarkable that Leach should have been unaware that those specimens were originally in the Sloanian Collection, and therefore brought from the West Indies. As the nomenclature has thus become confused, I have ventured to change the specific name; and retaining the generic one given by Dr. Leach, have adopted for the species the name *Guaia*, which Milne-Edwards had applied generically.

I find that in this genus, as well as in many others, the relative position of the three posterior spines affords a very fixed as well as tangible specific character. In the present species, the middle spine is but little higher than the lateral ones, which are very distant; whilst in *Lichtensteinii* the three are much nearer to each other, and form almost an equilateral triangle.

Persephona Lichtensteinii, Leach (Tab. XXXI. fig. 6). Testâ orbiculari, angulo pterygostomiano in dente producto, margine laterali unidentato; spinis posticis æqualibus, medio cum lateralibus triangulum æquilateralem designante.

Persephona Lichtensteinii, Leach, Zool. Miscell. iii. p. 22.
Hab. ——? Mus. Brit. ♂ et ♀.

Carapace orbicular, depressed, sparsely granulated; the pterygostomian angle produced into a prominent tubercle or tooth; another on the lateral margin on each side; the three posterior spines equal, and so placed as to form the points of an equilateral triangle. Front broad and nearly straight. External foot-jaws with the inner stalk in the male nearly plain, with only a slight longitudinal groove; in the female more deeply grooved towards the inner margin. Anterior legs more slender than in the other species. The arm wholly covered with small tubercles: a line of granules on the outer side of the wrist. The two specimens in the British Museum are a male and a female; unfortunately, the abdomen is wanting in each.

Length of carapace 1·2 in.

It is remarkable that the two specimens above referred to in the British Museum are the only ones known of this species. There is no figure extant, nor any account of it beyond the meagre definition given by Leach in the 'Zoological Miscellany,' and which is

in fact scarcely intelligible. It is a remarkable and interesting form, and in its orbicular outline resembles two new species which are in my collection, from the Western Coasts of America. It differs from all others of the genus in having a tooth or produced tubercle, on each side, on the margin of the carapace.

Persephona orbicularis, mihi (Tab. XXXI. fig. 7). Testâ orbiculari, angulo pterygostomiano in tuberculo abruptè producto; spinis posticis æqualibus, angulum ferè rectum designantibus.

Hab. ad Valparaiso. Mus. Bell.

Carapace orbicular, the latero-anterior margin slightly waved, the regions rather distinct, surface somewhat punctate, with numerous minute granules, which are more thickly crowded on the lateral margin and on the posterior portion; the front with a very slight triangular notch; pterygostomian angle produced into a distinct tubercle; the three posterior spines short, acute, recurved, the upper one forming with the two inferior almost a right angle. External pedipalps with the stalk grooved longitudinally, and in the female the inner grooved portion separated from the outer by a ciliated ridge. Anterior legs, with the arm, wholly tuberculated, the wrist granulated; fingers the length of the arm. Abdomen (female) with the first three segments, and the base and margin of the shield, tuberculated.

The colour is dull yellowish, regularly mottled with dull and pale red.

Length of carapace 1·5 in.

The only specimen I am acquainted with of this species is a female, which was brought from Valparaiso by Mr. Miller, Surgeon R.N., and is in my collection.

Persephona Edwardsii, mihi (Tab. XXXI. fig. 8). Testâ suborbiculari, anticè subproductâ, angulo pterygostomiano obsoleto; spinâ posticâ mediâ lateralibus multò altiore, paulò longiore.

Hab. ad insulas Galapagos. Mus. Bell.

Carapace nearly orbicular, somewhat produced and narrowed anteriorly, minutely punctate, covered, excepting at the anterior portion, with very small distinct granules, of which a distinct line borders the latero-anterior portion; the anterior margin waved, the pterygostomian angle obsolete, marked only by a slight elevation. Front broad, slightly emarginate; lateral and posterior margin much rounded, the spines placed in nearly a right-angled triangle, nearly equal, recurved at the apex. Anterior legs with the arm everywhere tuberculated, the wrist slightly granulated on the inner side, the hand minutely punctate. External pedipalps as in *P. orbicularis*. Abdomen (female) slightly granulated at the posterior and lateral portions.

Colour pale buff.

Length of carapace 1·3 in.

Of this species two specimens were brought by Mr. Cuming from the Galapagos. They were dredged in coral sand at 6 fathoms.

I have dedicated this species to my friend Professor Milne-Edwards.

Genus Leucosilia, Bell.

Char. Gen.—*Testa* orbicularis, subglobosa, fronte dentibus binis divergentibus terminatâ; regione intestinali unidentatâ. *Fossæ antennariæ* obliquæ, e dentibus frontis excavatæ. *Orbita* fissuris tribus. *Pedipalpi externi* caule exteriore subcurvo apice obtuso. *Pedes antici* robusti, longitudine mediocres. *Abdomen* Maris segmentis tertio, quarto, quinto coalitis, penultimo unidentato,—Fœminæ latè ovatum, valdè convexum.

Species unica, Leucosilia Jurinii (Tab. XXXII. fig. 1).

Guaia (*Ilia*) *Jurinii*, Sauss.

Hab. ad insulas Galapagos. Muss. Brit., Bell.

Carapace orbicular, very convex, the sides rounded, the surface covered with large contiguous granulations, excepting on the frontal and part of the hepatic regions, which are smooth: there is a small elevation on each hepatic region. The front with two small, triangular, divergent teeth, forming the hood-shaped roof of the antennary fossæ, which are oblique and open. Orbits with three small fissures. There is a single obtuse tooth or tubercle on the intestinal region. External pedipalps with the outer branch very slightly curved, not dilated as in *Myra*, nor narrowed forwards as in *Persephona*, but with nearly parallel margins. Abdomen in the male very long, triangular, the penultimate segment with a strong, sharp tooth directed backwards; in the female broad oval, very convex, with a broad central carina. The whole body above and below, with the exception before stated, covered with large granulations. Anterior legs much resembling those in *Persephona*, half as long again as the carapace, the arm granulated, the hand short and thick, the fingers very slightly curved, armed with very small distinct tubercles, the points crossing a little when closed.

Length of carapace 0·8 in.

The grounds upon which I have considered it necessary to constitute this species a separate genus from those with which it is most nearly allied, particularly from *Persephona*, are perhaps rather to be found in its general habit and aspect, than in any very prominent distinctions in the structure of those organs upon which the generic characters are usually understood to depend; although even in these essential respects there are sufficient peculiarities to justify the separation. It is impossible not to be struck at first sight with the remarkable globular form of the body in each sex, so different from the oval form of *Myra* and of the male of *Persephona*, as well as from the depressed character of both sexes of the latter genus; whilst the existence of only a single small tubercle on the posterior part of the carapace removes it obviously from all the species of both these genera, which have invariably three teeth at that part; and from *Ilia*, in which there are four. The general form of the body approaches the last-named genus more than any other, but in its more important characters it is essentially different from it. From *Persephona* it differs in the form of the antennary fossæ, and consequently in that of the front, the two teeth of which form the roof of those cavities in the present genus.

This species appears to be the same as that which has received from M. de Saussure the name of "*Guaia* (*Ilia*) *Jurinii*," and there are several specimens in the British Museum

to which that name has been attached. The specimens in my possession were taken by Mr. Cuming at the Galapagos Islands.

Genus Myra, Leach.

Char. Gen.—*Testa* ovato-globosa, posticè tridentata. *Orbita* fissuris tribus profundis. *Fossæ antennariæ* obliquæ. *Pedipalpi externi* caule exteriore ad marginem exteriorem dilatato. *Pedes antici* longissimi, graciles, manibus rectis. *Abdomen* Maris segmentis a tertio ad sextum,—Fœminæ a quarto ad sextum coalitis.

Of this genus a single species only has hitherto been described; namely, *Myra fugax* of Leach (*Leucosia fugax*, Fabr.). To this I have now to add four new species, of all of which there are specimens in the collection of the British Museum and my own. In this genus there is a close resemblance on the one hand to *Ilia*, and on the other to *Persephona*. To the former it is connected by *M. fugax*, and to the latter by *M. mammillaris*; but from both it is distinguished by characters sufficiently marked. From *Ilia* it is at once known by the absence of the peculiar twist of the hand, and from *Persephona* by the dilatation of the external stalk of the pedipalps. The five species are all natives of the Eastern Seas.

Myra fugax, Fabr. Testâ subglobosâ, in medio elevatâ, non carinatâ, spinâ posticâ mediâ lateralibus bis longiore, spinis lateralibus compressis.

? Rumph. Mus. t. 10. f. C.
? Browne, Jam. t. 42. f. 3.
?? *Cancer punctatus*, Linn. Syst. Nat. p. 1054. 36. ? Herbst, i. p. 89. t. 2. f. 15, 16.
Leucosia fugax, Fabr. Suppl. p. 351.
Myra fugax, Leach, Zool. Misc. iii. p. 24. Edw. Hist. Nat. des Crust. ii. p. 126; Règ. Anim. Cuv., Crust. t. 25. f. 3. De Haan, Crust. Japon. p. 134. t. 33. f. 1.
Hab. in mari orientali.

There is considerable doubt as to the identity of this species with the figures above referred to of Brown and Herbst, as well as with the *Cancer punctatus* of Linnæus. The figure of Herbst very possibly belongs to *M. carinata* of this paper.

Myra affinis, mihi (Tab. XXXII. fig. 2). Testâ ovato-globosâ, spinis posticis brevibus, subæqualibus; pedibus anticis thorace vix bis longioribus; manu digitis tertiâ parte longiore.

Hab. ad insulas Philippinas. Mus. Brit.

This species very much resembles *M. fugax*, but differs in several obvious characters, shown in the following comparative view:—

Myra fugax.	Myra affinis.
Anterior legs in the male three and a half times as long as the carapace.	Anterior legs not twice as long as the carapace.
Fingers half the length of the hand.	Fingers two-thirds the length of the hand.
Middle spine long, acute.	All the spines short and obtuse.
Male abdomen more than twice as long as it is broad.	Male abdomen much less than twice as long as broad.

These characters, taken in both cases from males, are constant, as far as we can judge from the examination of several specimens in the British Museum.

Length of carapace 1·3 in.

Myra carinata, mihi (Tab. XXXII. fig. 3). Testâ ovatâ, minutè granulatâ, carinatâ; spinâ posticâ mediâ lateralibus ter quaterve longiore, lateralibus conicis, acutis.

?? *Cancer punctatus*, Herbst.

?? *Ilia punctata*, Edw. Hist. Nat. Crust. ii. p. 125.

Hab. ad insulas Philippinas. Muss. Brit., Bell.

Carapace ovate, minutely granulated, particularly at the posterior part, distinctly but slightly carinated along the centre; the hepatic ridge and lateral margin granulated, the former having a small tubercle; the pterygostomian tooth broadly triangular; the central spine on the intestinal region at least three times as long as the lateral ones, which are conical and acute. The anterior pair of legs in the female twice the length of the carapace, exclusive of the spine; the arm covered with tubercles; the hand slightly tumid near the base, but less so than in *M. fugax*, narrowed forwards; fingers closed throughout their length, finely toothed. Abdomen in the female with the fourth, fifth and sixth segments united, as in *M. fugax*.

Length of carapace 1 in.

The most obvious distinction between the present species and the one previously known, consists in the carinated form of the carapace, which, although not very strongly marked, is quite distinct, and differs obviously from the rounded surface of *M. fugax*. Another important distinction is in the comparative length of the three spines on the hinder part of the carapace, the central one being in the present species so much longer in proportion to the lateral ones than it is in the former. Whether this is the species figured by Herbst as *Cancer punctatus* I am not sure, but it resembles very closely his figures assigned to that species. As Professor Milne-Edwards refers to that authority for his *Ilia punctata*, and as those figures certainly do not represent an *Ilia* at all, I am inclined to doubt the existence of such a species of that genus, and to refer it to *Myra*.

Myra elegans, mihi (Tab. XXXII. fig. 4). Testâ bis longiore quam latiore (spinâ posticâ non inclusâ), margine anteriore setoso.

Hab. in mari orientali. Mus. Brit.

Carapace oval, twice as long as broad, the central posterior spine nearly half the length of the carapace, the lateral ones extremely small; a slight longitudinal carina, which is granulated, and there are patches of granules on the branchial and cardiac regions; front produced, slightly emarginate. From the front to the hepatic region the margin has a line of stiff curved setæ. External pedipalps quite plain; the outer margin of the palp less dilated than in other species. The legs very slender; the arm granulated. The fingers longer than the hand; the four posterior pairs of feet, particularly the fifth pair, with the last two joints strongly ciliated. Abdomen of imperfect female oval, with the third to the fifth segments united.

Length of carapace, without the spine, 0·4 in.; of the spine, 0·2 in.

Of this small and gracile species, one specimen, an imperfect female, exists in the

British Museum. It has a *primâ facie* resemblance to a young *M. carinata,* but differs from that species in its proportions, in the arrangement of the granules, in the hairy line on the anterior margin, and in the ultimate and penultimate joints of the posterior feet being ciliated.

MYRA MAMMILLARIS, mihi (TAB. XXXII. fig. 5). Testâ ovatâ, glabrâ, tuberculis parvis elevatis sparsìm instructâ; dentibus posticis brevissimis, rotundatis.

Hab. ad oras Australiæ. Muss. Brit., Bell.

Carapace oval, somewhat produced before and behind, the surface polished, and studded with numerous small distinct globular tubercles, which also form a line along the middle of the back, around the margin, on the hepatic region, and on the pterygostomian crest. Front somewhat waved, slightly emarginate, a small tooth over the inner canthus of the orbit. The teeth on the posterior part rounded, not longer than broad, the lateral ones compressed. External foot-jaws tuberculated on the anterior portion, the palp somewhat dilated outwards. Sternum with lines of minute tubercles anteriorly. First pair of legs in the male twice the length of the carapace, stouter than in the other species of the genus; the arm covered with depressed tubercles; a scabrous line on the inner margin of the wrist, and on the outer and inner edge of the hand; the fingers half the length of the hand, sulcated and scabrous. The remaining legs filiform, slender, the surface punctated, the terminal joint awl-shaped, sulcated.

Length of carapace 2 in.

Of this fine species there are several specimens in the British Museum and in my own collection. It was brought from South Australia. Its *primâ facie* relation to *Persephona* is striking, but it differs from that genus in the essential generic characters, particularly in the form of the hand, and of the palp of the external foot-jaws.

Myra variegata of Rüppell (Krabben des Roth. Meeres, p. 17. t. 4. f. 4) is not a *Myra*, but is probably a young individual of a species of *Philyra*.

Genus MYRODES, Bell.

CHAR. GEN.—*Testa* ovata, rostro emarginato terminata, posticè dentibus tribus, quarum media longior, armata. *Orbita* fissuris tribus, brevibus. *Fossæ antennariæ* ferè longitudinales. *Pedipalpi externi* caule exteriore subcurvo, haud dilatato. *Pedes antici* testâ vix longiores; manibus pyriformibus, haud longioribus quam latioribus; digitis tenuibus valdè elongatis, curvis, apice aduncis. *Abdomen* MARIS triangulare, segmentis tertio ad sextum coalitis,—FŒMINÆ —— ?

This genus, which is nearly allied to *Myra*, differs from it in the following particulars. The antennary fossæ are less oblique in their direction, being so placed that the antennules lie nearly longitudinally. The palp of the external foot-jaws is merely curved on its outer edge, instead of being first dilated and then distinctly narrowed towards the apex, as in *Myra*. But the most remarkable peculiarity is in the form and length of the anterior legs, which in *Myra* are almost filiform, and, even in the female, more than twice as long as the carapace; whilst in the present genus they are not longer than that part, if in both cases we except the fingers. The hand especially, which in *Myra* is always many times longer than it is broad (in *M. fugax* ♂ not less than seven times), is in *Myrodes* as

broad as it is long. The fingers differ from those in any other genus of the family, with the exception of *Nursilia*, in their beautiful tenuity, their curvature, and their hooked points, which cross each other considerably when closed.

This genus may be considered as bearing the same relation to *Myra*, as *Leucosilia* does to *Persephona*; and as *Myra* and *Persephona* represent each other in the different hemispheres, so may *Myrodes* and *Leucosilia*.

Species unica, Myrodes eudactylus, mihi (Tab. XXXII. fig. 6).

Hab. ad insulas Philippinas. Muss. Brit., Bell.

Carapace minutely and sparsely granulated, distinctly but slightly carinated; hepatic region with a small ridge, and a marginal tooth; cardiac region separated from the branchial on each side by a slight depression; the posterior teeth rather small, the middle one the longest and placed a little higher than the others. Rostrum distinct, bifid, the two tooth-like projections forming the covering of the antennary fossæ, which are very open. External foot-jaws with the palp evenly curved on the outer edge, but without the dilatation which characterizes *Myra*. Anterior legs short, the arm minutely granulated; hand swollen at the base, narrowed forwards, as broad as it is long; the fingers slender, elegantly curved, longer than the hand, armed with sharp teeth and hooked at the extremity. Abdomen in the immature female lanceolate, with a rather broad shallow carina.

Length of carapace 0·9 in.

This beautiful species was brought by Mr. Cuming from the Philippines.

Genus Philyra, Leach.

Char. Gen.—*Testa* orbicularis, depressa, inermis, fronte epistomate breviore. *Fossæ antennariæ* ferè transversales. *Orbita* suprà aperta, trifissa. *Pedipalpi externi* caule exteriore dilatato. *Pedes octo posteriores* tarso compresso, lamelloso. *Abdomen* Maris hastato-lanceolatum,—Fœminæ articulo ultimo angusto valdè producto.

The character which has hitherto been considered as the essential one in this genus, namely the extraordinary dilatation of the palp of the foot-jaws, varies greatly in degree in the different species now known; the outline in some being scarcely less than semicircular, whilst in others it is not more curved than in *Myra*. This is another instance of the importance of taking into account the whole organization of the animal, instead of depending upon a single character of a single organ. The form of the carapace, the absence of all armature, the character of the legs and other parts, are in the present instance quite as important, and even more to be relied on, than the form of the palp of the external foot-jaws.

Philyra scabriuscula, Fabr. Testâ depressâ, granuloso-scabrâ, fronte epistomate multò breviore; brachiis tuberculatis, manibus ad marginem interiorem lineis duabus granulatis.

Hab. in mari Indico. Muss. Brit., Soc. Linn., Bell.

Vide Edw. Hist. Nat. Crust. ii. p. 132. t. 20. f. 9, 10.

Philyra globulosa, Fabr. Testâ globosâ, lævi, margine laterali granulato; fronte vix epistomate breviore, brachiis granulatis.

Hab. —— ? Mus. Brit.

Vide Edw. Règne Anim. Cuv. t. 24. f. 4.

Philyra porcellana, Fabr. Testâ globosâ, minutè punctatâ; fronte epistomate parùm breviore; margine granulato; brachiis cylindricis tuberculatis; manibus inflatis, lævibus.

Hab. —— ?

A specie præcedente anne distincta?

Vide Edw. Hist. Nat. Crust. ii. p. 133.

It appears that Leach considered this as not specifically distinct from *Ph. globulosa*, which is very probably correct.

Philyra Pisum, De Haan. "Fronte epistomate parùm breviore; regionibus pterygostomianis medio angulatis; thorace granulato; chelis in maribus thoracem dimidio superantibus; digitis in longitudinem 5 sulcatis, margine interno denticulatis." Testæ longit. unc. 0·8.

Crust. Japon. p. 131. t. 33. f. 7.

Hab. ad Japoniæ oras.

Philyra platycheira, De Haan. "Parva; regionibus pterygostomianis medio angulatis; fronte epistomate parùm breviore; chelis in maribus thorace bis longioribus, digitis valdè depressis, lævibus, margine interno integerrimis." Testæ longit. unc. 0·5.

Crust. Japon. p. 135. t. 33. f. 6.

Hab. cum præcedente et ad insulas Philippinas. Mus. Bell.

Of the foregoing species I have only seen specimens of the first two and of the last. Of *Ph. scabriuscula* there are several in the Banksian Collection of the Linnean Society, in the British Museum, and in my own collection. *Philyra globulosa* is in the British Museum; and of *Ph. platycheira* I have a specimen from the Philippines. I have endeavoured to select those characters which are essentially distinctive. Those of De Haan's two new species, I have taken verbatim from his work.

Philyra lævis, mihi (Tab. XXXII. fig. 7). Testâ, corpore, pedibus omninò lævibus.

Hab. ad Portum "Adelaide" Australiæ. Mus. Brit., Bell.

Carapace orbicular, smooth, but not polished; lateral margin thin, with a minute notch between the hepatic and branchial regions succeeded by a very slight angle, a minute projection over the second and another over the fifth pair of legs, and a small semicircular one on the middle of the intestinal region, the posterior margin flattened and turned up. Front with two small acute teeth in the centre, and two broader ones at the inner canthus of the orbit. The epistome not extending beyond the front. A rather prominent ridge on the pterygostomian region, which is without any granulations. The external foot-jaws with the palp dilated at the outer side, and then narrowed towards the apex; the buccal

opening a little expanding forwards. Anterior legs in the male robust, rather more than twice the length of the carapace; the arm cylindrical, entirely smooth; the wrist and hand smooth and polished; the latter somewhat tumid; the fingers as long as the hand, longitudinally grooved, armed with tubercles on the opposing edges, with a hiatus at their base. The anterior legs of the female much shorter and smaller than in the male. The remaining feet quite smooth and polished, the penultimate joint flattened, and with sharp edges; the nail long and styliform. Abdomen in the male with the first two segments waved, the third, fourth, fifth and sixth united, and forming, with the seventh, an elongated triangle somewhat hastate at the base, where there are two large elevations, and there is a broad groove along the centre. In the female the second to the sixth joints are united, forming a large, very convex shield, and the seventh joint, which is very narrow, is produced almost to the edge of the buccal orifice.

Colour brown, with several small yellower spots placed symmetrically, four of which are constant, and occupy the same situation as those which so distinctly characterize *Leucosia*, and which do not, I believe, exist in any others of the family.

Length of carapace 0·9 in.

I have received a large number of this interesting species from Port Adelaide in South Australia. The males and females were nearly equal in number. It may be at once distinguished from every other hitherto known, by the absence of all appearance of granulations on every part of the body, and even on the arms. There are also some specimens in the British Museum, from Van Diemen's Land, which differ from mine only in the less degree of prominence of the tubercles on the male abdomen.

PHILYRA ADAMSII, mihi (TAB. XXXIII. fig. 1). Testâ glabrâ, regionibus partìm et lineâ longitudinali granulatis; margine posteriore utrinque bituberculato.

Hab. ——? Mus. Brit.

The carapace of this little species is depressed, glabrous, with a granulated longitudinal line and patches upon several of the regions, which are separated by shallow sulci; front emarginate, posterior margin with two or three small tubercles on each side. External pedipalps with the palp not much dilated. Anterior legs more than twice the length of the carapace; arm subtriedrous, tuberculated above and below; a line of small granules on the outer side of the wrist; hand with a slight external and internal carina granulated; fingers sulcated. Male abdomen composed of four pieces, by the union of the second, third and fourth and of the fifth and sixth segments.

Length of carapace 0·4 in.

Obtained during the voyage of the Samarang, by Mr. Adams, after which indefatigable and intelligent naturalist I have named the species.

PHILYRA PUNCTATA, mihi (TAB. XXXIII. fig. 2). Testâ orbiculari, lævi, punctatâ; angulo pterygostomiano obsoleto; brachiis triquetris.

Hab. ad oras Africæ occidentalis. Mus. Brit.

Carapace nearly orbicular, smooth, punctate in every part; the margin distinct, with a

line of granulations; the pterygostomian angle scarcely existing. External foot-jaws with the palp moderately expanded. Anterior legs of moderate length, the arms triquetrous, minutely granulated; the hand smooth, half as long again as it is broad, the fingers very slightly toothed. Abdomen (male) with the third, fourth and fifth segments united; the others distinct.

Length of carapace 0·5 in.

It was dredged in Simon's Bay, South Africa, in sand, at the depth of from four to seven fathoms.

This species bears a considerable resemblance to *Ph. globulosa*. It is however much smaller, and is readily distinguished by the three-sided arm, and the less expanded palp of the foot-jaws.

Philyra carinata, mihi (Tab. XXXIII. fig. 3). Testâ partìm granulosâ, inter regiones cardiacam et branchialem lævi, medio carinatâ; manibus lineis duabus granulosis.

Hab. ad Insulam Borneo. Mus. Brit.

Carapace rather longer than broad, evenly rounded, partially covered with distinct granulations of various sizes, a broad space between the cardiac and branchial regions quite smooth, a slight carina along the middle, margin distinct and granulated; front nearly straight, slightly grooved. External foot-jaws with the palp but little dilated. Anterior legs of moderate size, the arm angular, granulated, excepting a long angular area which is smooth; hand as broad as it is long, with a line of small granulations on the upper surface and on the inner margin. Abdomen with only the fourth and fifth articulations united.

Length of carapace 0·6 in.

Distinct from all others by the carina on the carapace.

Philyra macrophthalma, mihi (Tab. XXXIII. fig. 4). Testâ ovatâ, minutissimè granulatâ; pedunculis oculorum elongatis; abomine (maris) angusto, lineari.

Hab. in mari Indico, ad Ins. "Sooloo." Mus. Brit.

Carapace ovate, narrowed posteriorly, covered with very minute granulations; front nearly straight, grooved; pterygostomian angle carinated; margin distinct, granulated. Eyes on foot-stalks as long as the front is broad, projecting forwards. Foot-jaws with the palp much dilated externally. Anterior legs short, smooth; hand as broad as it is long, fingers stout, strongly tuberculated at the edge, with a hiatus between them near the base; remaining feet with the last two joints ciliated.

Abdomen (male) nearly linear, bituberculated at the base.

Length of carapace 0·5 in.

The most remarkable character in this species is the length of the foot-stalks of the eyes, which is far greater than in any other of the family which I have seen. The linear form of the male abdomen is also remarkable.

Genus Ebalia, Leach.

Char. Gen.—*Testa* rhomboidalis vel subhexagona; fronte producto, emarginato. *Orbita* suprà fissuris duabus. *Fossæ antennariæ* tectæ, obliquæ. *Pedipalpi externi* ad marginem epistomatis extendentes, caule exteriore margine externo recto, interiore acuminato. *Pedes antici* breves, crassi; *posteriores* sensìm breviores, ungue forti, styliformi terminati. *Abdomen* Maris segmentis plurimis,—Fœminæ a tertio ad sextum confluentibus.

Of this genus the three species most commonly known are natives of the coast of Great Britain. The only other form to which it closely approximates is *Lithadia.* It was established by Leach, and is a perfectly natural and distinct genus. Dr. Milne-Edwards's opinion that our three forms are merely varieties cannot be admitted. The distinctions are tangible and constant.

Ebalia Pennantii, Leach. Testâ granulatâ, eminentiâ longitudinali et transversali cruciformi; margine latero-anteriore bilobato; abdomine maris segmentis a tertio ad sextum confluentibus.

Cancer tuberosus, Penn. Brit. Zool. iv. t. 9 *a.* f. 19.

Ebalia Pennantii, Leach, Malac. Brit. t. 25. f. 1–6. Edw. Hist. Nat. des Crust. ii. p. 129. Bell, Brit. Crust. p. 141.

Hab. ad oras Britanniæ. Muss. Brit., Bell.

The largest species of the genus.

Ebalia Bryeri, Leach. Testâ minutè granulatâ; margine laterali integro, subrevoluto, posteriore bilobato; regione cardiacâ bituberculatâ, branchiali utrinque unituberculatâ; brachio haud bis longiore quam latiore. Abdomen maris segmentis a tertio ad quintum,—fœminæ a tertio ad quartum coalitis.

Cancer tumefactus, Mont. Trans. Linn. Soc. ix. p. 86. t. 2. f. 3.

Ebalia Bryerii, Leach, Malac. Brit. t. 25. figg. 12, 13. Edw. *l. c.* p. 129. Bell, Brit. Crust. p. 145.

Hab. ad oras Britanniæ australes. Muss. Brit., Bell.

Ebalia Cranchii, Leach. Testâ granulatâ, carinatâ, tuberculis quinque; margine latero-anteriore ferè integro; brachio ter longiore quam latiore.

Ebalia Cranchii, Leach, Malac. Brit. t. 25. f. 7–11. Edw. *l. c.* p. 129. Bell, Brit. Crust. p. 148.

Hab. ad oras Britanniæ rarissimè. Muss. Brit., Bell.

Ebalia granulosa, Edw. (Tab. XXXIII. fig. 5). Testâ granulatâ, tuberculis sex; margine latero-anteriore bilobo.

Ebalia granulosa, Edw. *l. c.* p. 130.

Hab. ad insulam Corcyram. Mus. Brit.

Two specimens of this rare and very distinct species are in the British Museum; they were brought from the Island of Corfu.

Genus Phlyxia, Bell.

Char. Gen.—*Testa* rhomboidea, tuberculis tribus posticè instructa. *Orbita* suprà emarginata, fissuris duabus. *Fossæ antennariæ* cum orbitis communicantes. *Antennulæ* elongatæ. *Pedipalpi externi* caule

exteriore lato, margine externo curvo, anticè angustato; caule interiore segmento penultimo lateribus parallelis, ultimo triangulari. *Abdomen* in utroque sexu segmentis a tertio ad sextum coalitis.

A genus very nearly allied to *Ebalia*, but distinguished from it by several obvious characters; as the three tubercles on the posterior margin of the carapace, the rounded notch in the superior margin of the orbits, the communication of these cavities with the antennary fossæ, and the form of the external foot-jaws. There are three species in the British Museum, two of which are from Port Jackson, and the third from New Zealand. The latter, *P. lævis*, differs considerably from the other two, but must be referred to the same genus.

PHLYXIA CRASSIPES, mihi (TAB. XXXIV. fig. 2). Testâ subcarinatâ, rostro quadrato, quadridentato; pedibus anticis testâ plus quam duplò longioribus; brachiis rotundis medio tumescentibus.

Hab. ad oras Australiæ orientales. Mus. Brit.

Carapace rhomboidal, slightly carinated, the rostrum prominent, with four minute teeth, depressed in the centre; a triangular tooth on the margin of the hepatic region, and three slight projections on that of the branchial; posterior margin with three teeth, the central one conical, and placed a little above the other two, which are broadly triangular. Eyes conspicuous above; orbits with a broad rounded notch, and two small fissures. External foot-jaws smooth, the basal segment elongated, with parallel sides, the second joint of the stalk rhomboid, with a process where it joins the basal; terminal joint triangular; palp broad at the base, slightly curved on the outer margin, narrowed forwards; anterior legs twice and a half the length of the carapace; arm smooth, round, slightly thickened above the middle; wrist curved, smooth; the hand twice as long as it is broad, rounded, the fingers greatly deflexed, flattened, nearly as long as the hand, the moveable one with a notch near the base to receive a broad tubercle on the other; the remaining legs diminishing regularly in length from the second to the fifth, the joints slightly tumid, carinated on each side, the nail very long, slender and curved. Abdomen in each sex with the third to the sixth joints united, in the male lanceolate triangular, in the female with the shield formed by the united joints very round, the seventh joint very small and distinct from the others.

Length of carapace 0·5 in.

There are three specimens of this species in the British Museum, brought from Port Jackson. It may be considered as the type of the genus.

PHLYXIA LAMBRIFORMIS, mihi (TAB. XXXIV. fig. 1). Testâ carinatâ, rostro triangulari emarginato, margine latero-anteriore inciso, latero-posteriore acutè carinato.

Hab. ad oras Australiæ orientales. Mus. Brit.

Carapace rhomboidal, approaching to orbicular, granulose, tuberculated, carinated, the margin with a strong notch between the hepatic and branchial regions, an obtuse tooth on the former, and a sharp carina on the latter; of the three posterior teeth, the one on the intestinal region is acute and recurved, the marginal ones conical; anterior legs nearly twice as long as the carapace, rather slender, the fingers slightly deflexed.

PHLYXIA LÆVIS, mihi (TAB. XXXIV. fig. 3). Brachiis triedris; testâ lævi, margine laterali unidentato.

Hab. ad Novam Zealandiam. Mus. Brit.

Carapace rhomboidal, smooth, rostrum obtuse, slightly emarginate; margin of the branchial region with a single minute tooth, posterior margin with three obtuse teeth; anterior legs not twice as long as the carapace; arm three-sided, triangular, granulated; hand half the length of the arm, smooth, slightly carinated on the outer side, fingers hardly deflexed.

Length of carapace 0·4 in.

The generic characters are much less strongly marked in this species than in either of the others, but the form of the foot-jaws, the three teeth on the posterior margin of the carapace, its rhomboidal form and other points of structure, sufficiently show its close relation to them. It may be considered perhaps as osculant between this genus and *Ebalia*.

Genus LITHADIA, Bell.

Testa rhomboidea, rudis, regionibus gibbosis, rostro bifido, resupinato terminata. *Orbita* suprà et extrorsùm aperta. *Fossæ antennariæ* obliquæ. *Pedipalpi externi* caule exteriore ensiformi, anticè obtuso; interiore lanceolato, exteriore longiore. *Pedes antici* robusti, rudes; brachiis tuberculatis, ad marginem exteriorem cristatis; manibus cristatis, digitis approximatis. *Abdomen* MARIS segmentis tertio, quarto et quinto coalitis; FŒMINÆ ——?

The grounds upon which I have thought it necessary to assign a distinct generic rank to the species to which the above characters belong, closely allied as it is to *Ebalia*, are the extremely different general aspect of the whole animal, arising from the rough and strong prominence of the different regions, the projecting spines, the large and prominent granulations, so unlike any other form in this family, excepting *Oreophorus*, and some distinct though not very striking differences in the form of the external foot-jaws, the legs, and particularly the abdomen in the male.

Species unica, LITHADIA CUMINGII, mihi (TAB. XXXIII. figs. 6, 7).

Hab. ad oras Americæ centralis (Puerto Portrero). Mus. Bell.

Carapace very strongly marked by rude elevations, sharply circumscribing deep hollows. In the younger specimen of the two in my possession, the elevations are more numerous and distinct, and the sulci separating them are continuous; the difference in the older specimen arising from the confluence of several of these elevations, by which the sulci become merely four irregular circumscribed hollows, covered within with distinct granulations*. Posterior branchial lobe forming a triangular tooth; posterior lobes of the cardiac region similarly modified. Rostrum slightly turned up, emarginate.

* This difference is so remarkable, that the specimens might be considered as of distinct species were there not other instances of similar variations in the surface, either from difference of age or from some ordinary law of variety. The tubercles, for example, which in the normal form of *Eurynome aspera* are quite separate, and are distributed very equally and distinctly over the carapace, are occasionally more or less confluent, forming a few tabulated surfaces; and it has, in this state, been described by Risso as a distinct species, under the name of *Eu. scutellata*. I have specimens exhibiting intermediate states.

External foot-jaws, sternum and abdomen covered with distinct large and elevated granulations. Abdomen in the male elongate triangular; the first and second segments transversely linear, the third, fourth and fifth united, with a minute tooth at the posterior angles, two rounded elevations on the hinder portion, and a slight mesial carina; the sixth segment oblong quadrate, the posterior margin armed with a strong tooth projecting backwards. First pair of legs very irregular, the arms tuberculated and granular; the hand nearly as broad as it is long, distinctly carinated on the outer side; fingers nearly touching each other throughout their whole length, and slightly tuberculated.

Colour pale brown; the hollows of the carapace grey: there are four minute red dots on the abdomen.

Length of carapace 0·7 in., breadth 0·6.

Two specimens (males) were obtained by Mr. Cuming, at Puerto Portrero, Central America, on fine sand, at thirteen fathoms.

Genus OREOPHORUS, Rüppell.

CHAR. GEN.—*Testa* tuberosa, posticè supra pedes dilatata. *Fossæ antennariæ* obliquæ. *Pedipalpi externi* caule exteriore arcuato, apicem versus sensìm angustiore. *Pedes anteriores* longi, robusti; *octo posteriores* subæquales, sub scuto dorsali reconditi. *Abdomen* MARIS?—FŒMINÆ latè ovatum, segmentis à tertio ad sextum coalitis.

This genus, established by Rüppell, constitutes the sole form of the present family which can be considered as offering a distinct approach to any other in its general characters. Its relation to the *Calappadæ*, and particularly to the typical genus of that family, has been already adverted to; and the principal character by which it is allied to that group, and by which also the genus *Calappa* is distinguished from its congeners, namely the latero-posterior expansion of the carapace, by which the ambulatory legs are capable of being concealed, obtains in all the species at present known. The species first discovered, and on which the genus was founded by Dr. Rüppell, was described and figured by him in his work on the Crustacea of the Red Sea. A second species was obtained by Mr. Adams in the Straits of Sunda, and appears in the Natural History (Crustacea) of the Voyage of the Samarang; and a single specimen of a third, now first described, the habitat of which is unknown, exists in the British Museum.

There is a certain approach to this genus in the general aspect of *Lithadia*, particularly in the hollows and elevations of the shell.

OREOPHORUS HORRIDUS, Rüppell. Testâ subtriangulatâ, regionibus branchialibus fortitèr et obliquè carinatis; chelis mediocribus, manu digitis longiore.

Oreophorus horridus, Rüppell, Krab. der Roth. Meer. p. 19. t. 4. f. 5. Edw. Hist. Nat. Crust. ii. p. 131.
Hab. in Mari Rubro.

The discovery of two other species since Rüppell's publication has rendered a new specific distinctive character necessary. The strong deep carina extending obliquely across each branchial region distinguishes it from both the others, and the comparatively normal form of the claws from *O. reticulatus*.

Oreophorus reticulatus, Adams and White. Testâ subpentagonâ, reticulatâ; digitis maximis, manu bis longioribus.

Oreophorus reticulatus, Adams and White, Crust. Voy. of the Samarang, p. 54. t. 6. f. 1.
Hab. in Mari orientali. Mus. Brit.

Readily distinguished from the other species by the enormous development of the fingers, the immoveable one being half as long as it is broad, and both twice as long as the hand. It is beautifully figured in the work above referred to.

Oreophorus nodosus, mihi (Tab. XXXIII. fig. 8). Testâ nodosâ, margine undato; manu tumidâ, ad margines carinatâ, bisulcatâ, digitis longiore.
Hab. ——? Mus. Brit.

Carapace generally rugose, but without the deep hollows which are seen in *O. reticulatus*, or the regular elevated carinæ on the branchial region of *O. horridus*. It is of a general semicircular form, with irregularly waved margin, a strong projection on the hepatic region, a large prominence on the anterior, and a double one on the posterior part of the branchial region; front emarginate. External pedipalps with the outer stalk slightly arched; the inner with a longitudinal groove close to the inner edge, and a slight carina along the middle line. Anterior legs of moderate length and size, the arm nodose, the hand inflated, with two longitudinal sulci, and an external and internal carina; the fingers slender, curved, and shorter than the hand. The abdomen is wanting in the only specimen known, which is a male.

Length of carapace 0·7 in.; breadth 0·8.

The specimen in the British Museum is, I think, doubtless an old and faded one, and is consequently thin and slight compared with its original condition. It is of a delicate pink colour.

Genus Nursia, Leach.

Char. Gen.—*Testa* polyhedra, fronte producto. *Orbita* extrorsùm aperta. *Fossæ antennariæ* transversæ. *Pedipalpi externi* caule exteriore curvo, dilatato, anticè et posticè obtuso; caule interiore margine interno recto, articulo penultimo quadrato, ultimo triangulari. *Pedes antici* digitis deflexis. *Abdomen* Maris articulo penultimo apicem prope processu dentiformi instructum.

Nursia plicata, Herbst (Tab. XXXIV. fig. 4). Testâ utrinque 4-dentatâ, medio tuberculis tribus triangulum delineantibus, posticè lineâ elevatâ transversâ tuberculum gerente, fronte 4-dentato.

Cancer plicatus, Herbst, iii. No. 253. t. 59. f. 2.
Nursia Hardwickii, Leach, Zool. Misc. iii. p. 20.
Hab. in oceano Indico. Mus. Brit.

Carapace somewhat broader than it is long, produced anteriorly, granulated; a notch between the hepatic and branchial regions, the latter tumid, broadly margined, the margin with four obtusely triangular dentiform projections, of which the posterior are the most prominent, projecting considerably beyond the line continued from the lateral margin of the carapace. The anterior regions are carinated, and an elevated line runs between the hepatic and branchial regions, each terminating in a tubercle, which, with its fellow

and a single tubercle on the cardiac region, forms an equilateral triangle; a transverse elevated line crosses the posterior part of the branchial and the cardiac regions, on the centre of which is the single tubercle just mentioned, and another elevated line crosses the posterior part of the carapace, also having a tubercle on the centre.

Length of carapace 0·5 in.

I have no doubt whatever that Herbst's figure belongs to this species. It is considerably broader in proportion to the length than the specimens in the British Museum, but these also differ in this respect from each other. I have restored Herbst's name, which I do with the less hesitation, as his is the only original figure which has hitherto appeared, and we have no other original notice of the species than the short but correct and expressive description given by Leach. I have also given a figure of the species on account of the imperfection of that of Herbst. The specimens in the British Museum, which are the only ones with which I am acquainted, were brought from India by the late General Hardwicke. These differ among themselves in some particulars, but, as it appears to me, not sufficiently to justify a specific distinction.

Nursia abbreviata, mihi (Tab. XXXIV. fig. 5). Testâ orbiculari, margine undato, lineâ elevatâ longitudinali, alterâ transversali decussatâ; fronte integro.

Hab. in oceano Indico. Mus. Brit.

Carapace very flat, nearly orbicular, the front slightly projecting, entire; the margin granulated and waved, forming seven slight rounded prominences, exclusive of the front; an obtuse elevated line runs down the middle of the carapace from the front to the cardiac region, crossed by a transverse one which is granulated, commencing between the anterior and posterior lobes of the branchial region, and crossing over the genital. The anterior legs (in the female) are of moderate length, the hand not one-third longer than broad, with two granulated lines on the upper side; the fingers short, meeting at the greater part of their length, but with a hiatus near the base. The external foot-jaws have the outer stalk or palp considerably curved, rounded at each extremity; the inner stalk with the internal margin straight, meeting its fellow the whole length. The abdomen in the female (the only sex I have seen) broad ovate, the fourth, fifth and sixth segments united, and indications of them in slight transverse depressions.

Length of carapace 0·4 in.

Genus Nursilia, Bell.

Char. Gen.—*Testa* latior quam longior, margine polygono, fronte producto. *Orbita* bifissa, extrorsùm aperta. *Fossæ antennariæ* obliquæ. *Pedipalpi externi* epistomati superantes, caule exteriore curvo, medio dilatato; interiore elongato, margine interno arcuato. *Pedes antici* graciles, manu tumidâ, digitis curvis dentatis manu longioribus. *Abdomen* Maris ——?—Fœminæ valdè convexum, articulo ultimo inter bases pedipalporum externorum producto.

This genus has a close affinity with *Nursia*, but differs from it in the form of the pedipalps, the interior margin of which is curved, so that a space exists between them excepting at the apex; the anterior legs are much more slender, and the form of the hand and fingers is very different, resembling almost exactly that of *Myrodes*.

Species unica, NURSILIA DENTATA, mihi (TAB. XXXIV. fig. 6).

Hab. in oceano Indico. Mus. Brit.

Carapace rather broader than long, the margin laminated; a slight fissure between the hepatic and branchial regions, an obtusely triangular tooth on the margin of the former, and three slight angular projections on the latter; several small projecting teeth on the surface of the carapace, and a longitudinal carina, on the posterior half of which are three strong spines curved forwards; an elevated line on the branchial region. External foot-jaws extending forwards to the frontal margin, meeting only at the apex, and leaving an interspace, the posterior part of which is filled by the last joint of the abdomen. The anterior legs are long and slender, the hand tumid on the proximal portion; the fingers longer than the hand, very slender, curved at the extremity, and finely toothed. The abdomen of the female extremely convex, the terminal joint somewhat triangular, and extending forwards between the base of the foot-jaws.

A single specimen, a female, is in the British Museum.

Genus ARCANIA, Leach.

CHAR. GEN.—*Testa* globulosa, spinis seu tuberculis elevatis plurimis armata. *Orbita* suprà et extrorsùm aperta. *Fossæ antennariæ* longitudinales. *Pedipalpi externi* caule exteriore recto, lineari, apice interiore emarginato-truncato; caule interiore gradatìm acuminato. *Pedes antici* gracillimi. *Abdomen* MARIS lanceolatum, segmentis a tertio ad sextum vel ad quintum coalitis.

This genus is closely allied to *Iphis*, from which it differs in the more globular form of the body, in the number and character of the spines with which it is armed, and in the form of the external foot-jaws.

ARCANIA ERINACEUS, Herbst. Corpore atque membris densè spinosis, spinis spinulosis.

Cancer Erinaceus, Herbst, t. 20. f. 111.

Leucosia Erinaceus, Fabr. Suppl. p. 352.

Arcania Erinaceus, Leach, Zool. Miscell. iii. p. 24. Edw. Crust. ii. p. 134.

Hab. in mari Indico. Muss. Brit., Soc. Linn., Bell.

A well-known species, figured by Herbst and by several subsequent authors. It differs from other species in the numerous spines with which it is armed, and in the spines being themselves spinulose.

ARCANIA UNDECIM-SPINOSA, De Haan. "Thorace spinuloso, spinulis obtusis, ambitu 11-spinoso, spinis acutis simplicibus; brachiis granulatis, digitis manibus longioribus."

De Haan, Crust. Japon. p. 135. t. 33. f. 8.

Hab. in Japoniâ.

ARCANIA NOVEM-SPINOSA, Adams and White. "Thorace lævi, granuloso, marginibus latero-anterioribus spinis duabus, latero-posterioribus spinis duabus, posteriore spinâ longâ rectâ."

Iphis novem-spinosa, Adams and White, Crust. of the Voyage of the Samarang, p. 56. t. 13. f. 1.

A close examination of the specimen in the British Museum, described by Messrs. Adams and White as "*Iphis*," has fully confirmed the impression I had received from their figure that this is a true *Arcania*. Its general form is that of this genus, differing greatly from that of *Iphis*; and its resemblance to *A. undecim-spinosa* of De Haan is very close. In fact it scarcely differs excepting in the number of spines.

Arcania septem-spinosa, mihi (Tab. XXXIV. fig. 7). Testâ globulosâ, paulò latiore quam longiore, tuberculatâ, spinis septem tuberculatis armatâ, laterali utrinque reliquis longiore.

Hab. ——? Mus. Brit.

Approaching *Iphis* in form, particularly in the transverse diameter of the carapace a little exceeding the longitudinal, and being furnished with two lateral spines longer than the others. The spines in this species, as in *Arc. tuberculata* and *Erinaceus*, are themselves tuberculated. The posterior pair of marginal spines, which are flattened, show this character in a very beautiful manner, as is seen in the figure (*d*). The anterior legs are slender, the arm slightly curved, covered with tubercles; the hand smooth, swollen at the proximal portion; the fingers very thin, curved, nearly as long as the hand, toothed, and meeting only at the points. The remaining feet are wanting in the specimen, excepting one, and the rest have been added in outline in the figure, from the nearly allied species.

Length of carapace 0·4 in.

Arcania tuberculata, mihi (Tab. XXXIV. fig. 8). Testâ paulò longiore quam latiore, omninò tuberculatâ, margine spinis novem tuberculatis instructo; brachiis granulatis, manibus lævibus.

Hab. ad ins. Borneo. Mus. Brit.

Carapace subglobose, covered with various-sized tubercles; at the lateral and posterior margin there are nine spines occupying the same situations as those in the larger species, and obviously replacing them; these spines are themselves tuberculated. The whole of the under surface is granulated, as is the arm; the hand quite smooth.

Length of carapace 0·4 in.

Arcania gracilipes, mihi (Tab. XXXIV. fig. 9). Testâ granulosâ, tuberculis quindecim suprà, et tribus ad marginem posteriorem instructâ; pedibus anticis tenuissimis.

Hab. ad ins. Borneo. Mus. Brit.

The whole carapace is granulated; there are fifteen distinct tubercles on the upper part and sides, and three on the posterior margin. The anterior feet are extremely slender, the fingers as long as the hand, and meeting only at the points.

Length of the carapace 0·3 in.

Arcania lævimana, mihi (Tab. XXXIV. fig. 10). Testâ granulatâ, tuberculis numerosis distinctis, ad marginem spinis novem simplicibus armatâ; manibus glabris.

Hab. ad insulas Philippinas. Mus. Brit.

Readily distinguished from the two former species by the number and character of the tubercles, and from *Arc. tuberculata* by the spines being simple.

Length of carapace 0·4 in.

Of each of the last four species of *Arcania*, there is a single specimen in the British Museum. From their small size, it is not improbable that some of them are young, but certainly not of any previously described species.

Genus Iphis, Leach,

Char. Gen.—*Testa* rhomboidalis, transversa, angulis rotundatis, utrinque spinâ longissimâ horizontali armata, fronte emarginato. *Orbita* aperta, bifissa. *Antennulæ* ferè longitudinaliter inflexæ. *Pedipalpi externi* caule interiore sublineari, anticè paulò angustiore. *Pedes* filiformes, graciles.

This genus is at once distinguished from *Arcania* by the rhomboidal form of the carapace, in which it somewhat resembles *Ebalia*. Its nearest affinity however is to *Arcania*, which it approaches in the armature of the periphery of the carapace, in the foot-jaws, the feet and other parts. One species of this genus only is at present known, viz.

Iphis septem-spinosa, Herbst.

Cancer septem-spinosus, Fabr. Mantissa, i. p. 325. Herbst, i. t. 20. f. 112.
Leucosia septem-spinosa, Fabr. Suppl. p. 351.
Iphis septem-spinosa, Leach, Zool. Miscell. iii. p. 25. Edw. Hist. Nat. Crust. ii. p. 139.

Iphis novem-spinosa of Adams and White is referred to the genus *Arcania*.

Genus Ixa, Leach.

Char. Gen.—*Testa* elliptico-rhomboidalis, processu utrinque subcylindrico à regione branchiali producto; regionibus sulco profundo separatis. *Orbita* suprà bifissa. *Pedipalpi externi* caule exteriore lato, obtuso, interiore longiore. *Pedes* omnes filiformes, tenues. *Abdomen* Fœminæ articulo ultimo usque ad oris aperturam producto.

Species unica, Ixa cylindrus, Fabr.

Cancer Cylindrus, Fabr. Mantissa, 251. Herbst, i. p. 108. t. 2. f. 29, 30, 31.
Leucosia Cylindrus, Fabr. Suppl. 352. Latr. Hist. Nat. Crust. vi. p. 119. Licht. Berl. Mag. 1815, p. 143.
Ixa Cylindrus, Leach, Trans. Linn. Soc. xi. p. 334.
Ixa canaliculata, Leach, Zool. Misc. iii. p. 26. t. 129. f. 1. Edw. Règ. Anim. Cuv., Crust. t. 24. f. 1; *Id.* Hist. Nat. Crust. ii. p. 135.
Ixa megaspis, Adams and White, Voyage of the Samarang, Crust. p. 55. t. 12. f. 1.
(Senior) *Ixa inermis*, Leach, *l. c.* t. 129. f. 2. Edw. Hist. Nat. Crust. ii. p. 135.
Hab. in mari Indico. Muss. Brit., Soc. Linn., Bell.

A careful examination of all the specimens of this genus to which I have access, amounting to about twelve, has led me to conclude that they all belong to one species. The variations which exist between any two of them are nearly as great as those which have given rise to the establishment of a distinct specific name in the case of *I. megaspis* of Messrs. Adams and White. I possess two specimens which were obtained by Mr. Hinds, which differ so much from others, that until I had carefully examined the whole of those I have alluded to, I had provisionally given them a distinct specific name.

The form and size of the lateral process vary considerably. In some it is cylindrical, in others it is somewhat conical; in some it is either direct or even bent slightly backwards, in others the apex is turned forward; in some there is a filiform appendage at its apex, in others there is not a vestige of this armature. The degree of granulation of the different parts also varies.

With respect to *I. inermis* of Leach, I see no difference but what might be supposed to depend upon great age; and the distinction is really less on examining the actual specimens, than appears to be the case from merely a comparison of the figures. Under these circumstances, I have ventured to give the references to the three supposed species, as synonyms of the old *Cancer Cylindrus* of Fabricius.

I have already observed that the genus *Harrovia* of Adams and White has no relation whatever to the present family. *Iphiculus* of the same authors, arranged by them amongst the Leucosiadæ, but stated in the same place to belong to the Parthenopidæ, appears to me to be nearly allied to the former family, and most probably associated with them. Certainly it has no near affinity with the Parthenopidæ. *Tlos* may be safely considered as allied to the Leucosiadæ. Unfortunately, neither the eyes, the orbits, the antennulæ, the antennary fossæ, nor the foot-jaws, are mentioned in the generic characters, or figured in the plates. See the Crustacea of the Voyage of the Samarang, pp. 55, 57. pl. 12. f. 5, pl. 13. f. 2. 5.

It is only since the foregoing paper has been in the press, that I have had an opportunity of seeing the magnificent work of Mr. James D. Dana, on the Crustacea obtained in the United States exploring expedition under the command of Mr. Charles Wilkes of the United States Navy. This work reflects equal credit on the author, and on the American Government for the liberal and handsome manner in which it has been published.

In this publication two species only are described as belonging to the present family, and of these one appears to me at least very doubtful as to its relation to it. I shall quote the characters of both as they are given by Mr. Dana:—

"Iphis longipes. Carapax parcè granulosus, suborbicularis, non latior quam longus [longior], armatus spinis duabus longissimis lateralibus latitudine carapacis vix brevioribus (unâ in latere utroque) et duabus minutis antero-lateralibus, duabus parvulis postero-lateralibus, et unâ posticâ corporis dimidium longitudine ferè æquante. Frons bilobatus parcè prominens. Pedes 8 postici prælongi."

Iphis longipes, Danâ in *op. cit.* p. 396. t. 25. f. 4.

"Taken from the stomach of a Tetraodon, among the reefs of Vití Lebu, Feejee Islands."

Of this species I have only to observe, that its form and characters rather tend to increase a doubt which I have before entertained of the propriety of generically separating the species of *Iphis* and *Arcania*. They appear to pass into each other by the present species on the one hand, and by *Iphis novem-spinosa* of Adams and White, which I have already transferred to *Arcania*, on the other.

Genus Nucia, Dana.

"Carapax parcè transversus, anticè non productus, latere non dilatatus, inermis, superficie paulò tuberculatus, fronte bilobatus et non saliens. Oculi paulò remoti, grandiores, marginales. Area buccalis benè triangulata. Maxillipedis externi articulus 3tius triangulatus; palpus angustus, extùs rectus. Pedes toti breves, et crassi, digiti in plano subverticali claudente, eodem cum manus articulatione."

Nucia speciosa, Dana, *l. c.* p. 397. t. 25. f. 5.

It is unnecessary to quote the description of the only species upon which this genus is founded. It appears to me that it is scarcely admissible into the family of Leucosiadæ, on account of the extraordinary size of the eyes, the thickness of the legs, and other characters, no less than the general form and aspect of the body. I give this opinion with deference in the absence of an actual specimen.

EXPLANATION OF THE PLATES.

Tab. XXX.

Fig. 1. *Leucosia orbicularis.* *a.* side view of the carapace; *b.* male abdomen; *c.* female abdomen.
Fig. 2. *Leucosia pallida.* *a.* side view; *b.* female abdomen.
Fig. 3. *Leucosia obscura.* *a.* side view; *b.* male abdomen; *c.* female abdomen.
Fig. 4. *Leucosia marmorea.* *a.* side view; *b.* male abdomen.
Fig. 5. *Leucosia punctata.* *a.* side view; *b.* anterior leg; *c.* male abdomen.
Fig. 6. *Leucosia affinis.* *a.* side view; *b.* anterior leg; *c.* male abdomen; *d.* female abdomen.
Fig. 7. *Leucosia brevimana.* *a.* side view; *b.* female abdomen.
Fig. 8. *Leucosia margaritacea.* *a.* side view; *b.* anterior leg; *c.* male abdomen.

Tab. XXXI.

Fig. 1. *Leucosia ocellata.* *a.* side view; *b.* anterior leg; *c.* female abdomen.
Fig. 2. *Leucosia Whitei.* *a.* side view; *b.* anterior leg; *c.* female abdomen.
Fig. 3. *Leucosia Cumingii.* *a.* side view; *b.* anterior leg; *c.* female abdomen.
Fig. 4. *Leucosia pulchella.* *a.* side view; *b.* anterior leg; *c.* male abdomen; *d.* female abdomen.
Fig. 5. *Leucosia phyllocheira.* *a.* side view; *b.* anterior leg; *c.* posterior leg.
Fig. 6. *Persephona Lichtensteinii.* *a.* side view.
Fig. 7. *Persephona orbicularis.* *a.* female abdomen.
Fig. 8. *Persephona Edwardsii.* *a.* female abdomen.

Tab. XXXII.

Fig. 1. *Leucosilia Jurinii.* *a.* side view; *b.* anterior leg; *c.* foot-jaw; *d.* male abdomen: *e.* female abdomen.
Fig. 2. *Myra affinis.* *a.* side view; *b.* male abdomen; *c.* female abdomen.
Fig. 3. *Myra carinata.* *a.* male abdomen.
Fig. 4. *Myra elegans.* *a.* side view; *b.* female abdomen.
Fig. 5. *Myra mammillaris.* *a.* male abdomen.
Fig. 6. *Myrodes eudactylus.* *a.* side view; *b.* anterior leg; *c.* foot-jaw; *d.* male abdomen: *e.* immature female abdomen.
Fig. 7. *Philyra lævis.* *a.* side view; *b.* male abdomen.

Tab. XXXIII.

Fig. 1. *Philyra Adamsii.* *a.* side view; *b.* anterior leg; *c.* male abdomen.

Fig. 2. *Philyra punctata.* *a.* side view; *b.* male abdomen; *c.* female abdomen.

Fig. 3. *Philyra carinata.* *a.* side view; *b.* male abdomen.

Fig. 4. *Philyra macrophthalma.* *a.* side view; *b.* detached eye; *c.* male abdomen.

Fig. 5. *Ebalia granulosa.* *a.* anterior leg; *b.* posterior leg.

Fig. 6. *Lithadia Cumingii.* *a.* side view; *b.* anterior leg; *c.* foot-jaw; *d.* male abdomen.

Fig. 7. *Lithadia Cumingii,* jun. *a.* side view; *b.* anterior leg; *c.* foot-jaw.

Fig. 8. *Oreophorus nodosus.* *a.* posterior view of the carapace; *b.* anterior leg; *c.* posterior leg; *d.* foot-jaw.

Tab. XXXIV.

Fig. 1. *Phlyxia lambriformis.* *a.* side view; *b.* foot-jaw; *c.* antennary fossæ; *d.* male abdomen; *e.* female abdomen.

Fig. 2. *Phlyxia crassipes.* *a.* male abdomen.

Fig. 3. *Phlyxia lævis.* *a.* side view; *b.* male abdomen; *c.* female abdomen.

Fig. 4. *Nursia plicata.*

Fig. 5. *Nursia abbreviata.* *a.* antennary fossæ, orbits and foot-jaw; *b.* under side of body.

Fig. 6. *Nursilia dentata.* *a.* side view; *b.* antennary fossæ, orbits and foot-jaw; *c.* under side of body.

Fig. 7. *Arcania septem-spinosa.* *a.* anterior leg; *b.* female abdomen; *c.* one of the central tubercles enlarged; *d.* posterior spine enlarged.

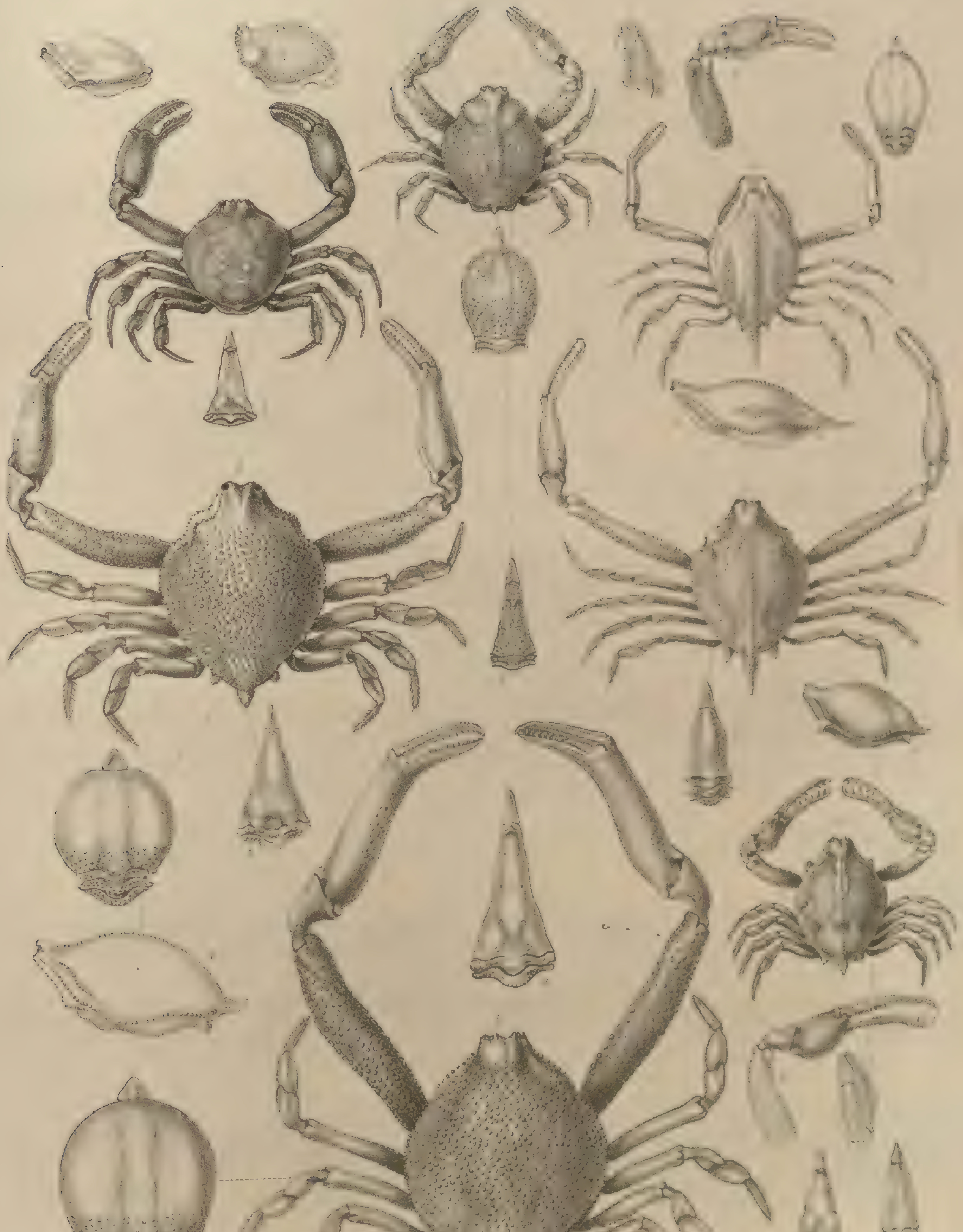
Fig. 8. *Arcania tuberculata.* *a.* male abdomen.

Fig. 9. *Arcania gracilipes.* *a.* abdomen of immature female.

Fig. 10. *Arcania lævimana.* *a.* female abdomen.

George B. Sowerby ad nat. Lith.

ad nat lith



XXXII. *Extracts from the* Minute-Books *of the* Linnean Society *of* London.

1849.

Mar. 20. It was unanimously resolved:—

> That the Council express its deep regret at the severe loss which the Society has sustained by the Death of its late Treasurer, Edward Forster, Esq., and its high sense of his long-continued and valuable services; and that this Resolution be communicated to his Nephew, Edward Forster, Esq., with the request that it may be also communicated to the other Members of his Family.

1850.

May 24. An Oil Painting, by Maguire, of the late Bishop of Norwich, President of the Society, was presented by the following Fellows, viz.:—

T. Bell, Esq.
J. J. Bennett, Esq.
F. Boott, M.D.
J. S. Bowerbank, Esq.
R. Brown, Esq.
G. B. Buckton, Esq.
G. Busk, Esq.
H. Cuming, Esq.
J. C. Dale, Esq.
G. E. Dennes, Esq.
W. H. Fitton, M.D.
J. Gadesden, Esq.
Viscount Goderich.
J. Gould, Esq.
G. R. Gray, Esq.
R. Heward, Esq.
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T. Horsfield, M.D.
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Sir G. T. Staunton, Bart.
R. Taylor, Esq.
W. Tebbitt, Esq.
R. Wakefield, Esq.
J. Walton, Esq.
Alfred White, Esq.
Dean of Winchester.
J. E. Winterbottom, Esq.
W. Yarrell, Esq.
J. Yates, Esq.

1852.

Dec. 7. The Bye-Law proposed by the Council on the 2nd of November to be added at the end of Chapter X. as follows:—

> "Sect. X. The Society shall not, and may not, make any Dividend, Gift, Division, or Bonus in Money, unto or between any of its Members,"

having been hung up in the common Meeting-Room of the Society, and read by the President, or Vice-President in the Chair, at the last two successive General Meetings of the Society, was put to the Ballot, and confirmed by the Fellows at large in the terms of the Charter.

1853.

May 24. Among the Presents announced was a Portrait of Linnæus, copied by Prof. Pasch from the original by Roslin, in the possession of the Royal Academy of

Sciences at Stockholm, for Archbishop Troil, by him presented to Sir Joseph Banks, and now presented to the Society by Robert Brown, Esq., President, for which the Special Thanks of the Society were directed to be given.

It was moved by Dr. Wallich, seconded by Dr. Boott, and unanimously resolved:—

> That the most grateful and cordial Thanks of the Society be offered to Mr. Brown, for the admirable manner in which, for more than three years, he has conducted the business of the Society as its President; together with the great and sincere regret of the Members that advancing years and the infirmities attending on them should have induced him to relinquish an office, in which it would have been their earnest desire long to have availed themselves of his invaluable services.

1854.

Mar. 21. The Treasurer, Mr. Yarrell, having communicated to the Council that the President has very liberally given a Donation of one hundred guineas for the use of the Society, it was moved by Mr. Miers, seconded by Dr. Boott, and unanimously resolved:—

> That the cordial Thanks of the Council be given to Thomas Bell, Esq., the President of the Society, for his liberal Donation.

CATALOGUE

OF THE

LIBRARY OF THE LINNEAN SOCIETY.

Continued from page 498 of Vol. XX. of the Society's Transactions.

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Kon. Nederlandsche Instituut van Wetenschappen. Verhandelingen der 1ste Klasse. 3de *Reeks,* Deel 1–5. *Amsterdam,* 1848–52. 4to.	The Institute.
Instituut of Verslagen en Mededeelingen. Nos. 3 & 4 (1844), Nos. 1–4 (1845), and Nos. 1–4 (1846). *ib.* 1844–46. 8vo.	———
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Jaarboek voor 1847–51. *ib.* 1847–52. 8vo.	———
Traduction du Mémoire accompagnant l'Adresse au Roi, par l'Institut Royale des Pays-Bas, pour les Sciences, les Lettres, et les Beaux-Arts. (1851.) 8vo.	———
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Bibliothecæ Societatis Artium Scientiarumque quæ Bataviæ floret, Catalogus Systematicus: curante P. Bleeker, anno 1846; *editio altera,* curante J. Munnich. *ib.* 1853. 8vo.	Dr. Bleeker.
Natuurkundige Vereeniging voor Nederlandsch Indië. Natuurkundig Tijdschrift voor Nederlandsch Indië. *Nieuwe Serie*; Deel 3, and Deel 4, Afl. 5 & 6. *Batavia,* 1854. 8vo.	The Association.
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PLACING THE PLATES

OF

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